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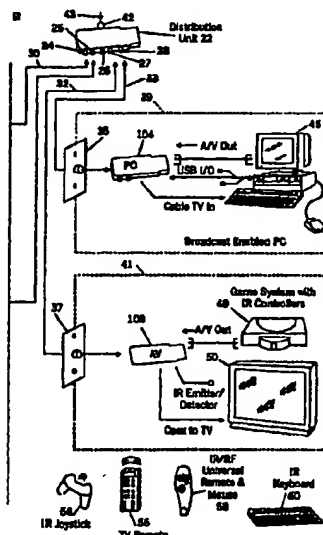
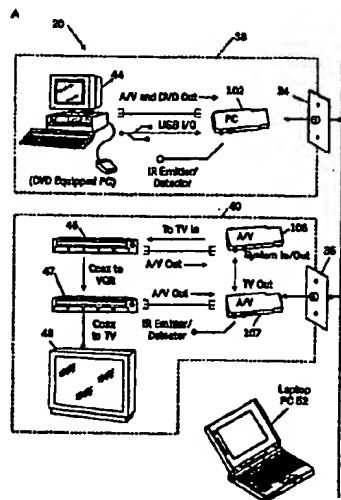
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(57) Abstract

Apparatus for distributing radio frequency (RF) modulated broadcast television signals from a broadcast signal source to networked appliances connected to the source through a plurality of single conductor coaxial cables, simultaneously with distributing unmodulated digital signals and RF modulated video signals exchanged between the networked appliances over the same network coaxial cables.

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Description

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**Entertainment and Computer Coaxial Network and Method of
Distributing Signals Therethrough**

Cross Reference to Related Applications

This application is related to and claims priority to U.S. Provisional Application Serial No. 60/107,681, filed November 9, 1998 and entitled "Home Entertainment Network."

Technical Field

This invention relates to signal networks, and more particularly to signal networks for interconnecting multi-media apparatus.

Background Art

According to computer industry estimates there are over 40 million homes in the United States with personal computers (PCs), and nearly half of these homes have more than one PC. The forecast is that these numbers will double in five years. Surveys of consumers with multiple PCs indicate that, in terms of priority, they want the PCs to be able to share files, printers, modems and the Internet, followed by the sharing of other peripheral equipment and the playing of network games. These shared applications require minimum signal transfer rates of 1Mb/s for satisfactory performance.

Similarly, more than 73 million homes nationwide are subscribers to cable television (CATV). The CATV services provide installed coaxial cable in one or more rooms of a house, resulting in the majority of subscribers having more than one television receiver (TV). Additionally, the expansion of CATV services to include internet access (i.e. "data over cable system interface specification" or DOCSIS) and the advent of consumer electronic products for internet use as well as for entertainment purposes, all promote a desire to network this equipment for shared use. Networking allows a PC in the home office to print documents on a printer in the family room, a VCR in the family room to be remotely controlled to display video on a kitchen TV, and a wireless

5 computer keyboard used with the family room TV to access work or game files on the PC in the home office. The alternative to networking is product duplication.

10 There is of course a cost associated with establishing a network. This is
5 the cost of installing the network wiring and the cost of purchasing and installing any interface devices which are necessary to adapt the appliances for
15 network operation. The current CEBus Standard installation guide for home networks specifies installation of a central distribution box ("Service Center") which receives all of the network signals, both internal and external. External
20 signals include radio frequency (RF) broadband signals from CATV, satellite dishes, and antenna received broadcast - collectively "RF broadcast signals", as well as DOCSIS. The internal signals are those from the networked appliances, including digital signals from digital signal apparatus, such as computers,
25 computer peripheral equipment, telephones and facsimile machines, as well as
15 RF modulated video signals produced by RF modulation of audio/video output signals from the networked multimedia A/V equipment.

30 To accommodate these different network signal forms and to permit bi-directional signal transmission between appliances via the distribution box (i.e. downstream and upstream transmission) the Standard specifies installation of
20 dual coaxial cables and one or more Category 5 twisted pair (TP) copper wires from the Service Center to outlets in each equipment room of the house.
35 Upstream signal transmission includes the RF modulated A/V signals from the network multimedia equipment which the interface devices provide over CATV
40 channel frequencies reserved by the owner for internal use. The downstream
25 coax signals include both RF broadcast signals, control signals, and the home user RF modulated A/V signals. The baseband, digital signal devices, including computers, modems, faxes and digital telephones communicate over the twisted
45 pair. The present estimated cost of installing CEBus Standard network wiring in new home construction is approximately \$1 per square foot, and the
30 estimated cost of upgrading existing homes is 2 to 3 times as much.

50 Alternatively, considering the broad installed base of CATV services

5 and the fact that there are an additional 30 million homes with CATV access, it
is desirable to provide for networking of the electronic appliances in a home
through the installed CATV cabling. As known, CATV services provide a
10 source signal connection to the home from a "head end", or local node of the
service provider's CATV system. Within the house the signals are distributed
from this head end connection through coaxial cables, which include a single
15 conductor plus a shield. Signal splitters are used to divide the source CATV
signal among the cables thereby providing the source CATV signal with a
substantially constant load impedance, while also providing signal isolation
10 between its output ports to prevent signals propagating from the source
connection from being cross coupled to the other output ports. The splitter,
therefore, prevents the upstream transmission necessary required for network
communications, which is the reason for the dual cable requirement of the
25 CEBus Standard.

15 Disclosure of Invention

One object of the present invention is to provide bi-directional signal
30 transmission over a single conductor coaxial cable. Another object of the
present invention is to provide a network capable of conducting simultaneous
20 bi-directional signal transmission of unmodulated digital signals, and radio
frequency (RF) modulated signals over a single conductor coaxial cable. Still
35 another object of the present invention is to provide a network capable of
providing bi-directional signal transmission of broadband, baseband and
infrared signals over a single conductor coaxial cable. Still another object of the
40 present invention is to provide bi-directional transmission of high bandwidth
25 broadband signals over a low bandwidth single conductor coaxial cable.

According to the present invention, a network includes one or more
45 single conductor coaxial cables routed within proximity to one or more local
groups of networked appliances, interface apparatus associated with each
30 networked appliance which use frequency division to separate the computer and
50 media signals from the local group appliances onto baseband and broadband

5 signal frequency channels within a local coaxial cable which couples the signals
to a central distribution unit apparatus. The distribution apparatus (unit)
receives all of the local cables and couples the baseband and broadband channel
10 signals of each cable, into each other local cable, to cause the baseband and
5 broadband signals from each networked appliance to be made available to each
other appliance.

15 In further accord with the present invention, the distribution unit or
apparatus further receives RF broadcast television signals which it mixes into
the broadband signal channel of each local cable, thereby additionally making
10 the RF broadcast signals available to each networked appliance concurrently
20 with the baseband and broadband signals from each other appliance. In a still
further accord with the present invention, each interface apparatus includes bi-
directional frequency filters for exchanging the computer and media signals
25 from the appliances with the signals from the baseband and broadband signal
15 channels of the local cable. In still further accord with the present invention the
distribution unit apparatus includes a signal bus for cross coupling the baseband
and broadband signals among the local cables, the bus having a signal path
30 geometry which minimizes signal interference within the baseband and
broadband frequency channels due to signal reflections occurring within the
20 network.

35 The present invention provides a fully functional network over single
conductor coaxial cable, such as that presently used in CATV installations,
thereby making network performance available at a significantly reduced cost.
The invention includes the use of a novel signal distribution unit which
40 25 interconnects the individual coaxial cables to the CATV signal source
connection without the use of signal splitters or signal combiners. The network
incorporates a multi-master approach with respect to the networked appliances.
45 The network provides for computer signal speeds of 1.0 Mbps, a 125 Kbps
signal speed for infrared control, and up to 158 television channels. The
30 network also provides the network user with the choice of up to sixteen
50 broadcast channels to be reserved for use within the home for audio/video

5 transfer to any room having cable access. These reserved channels may be used
for DVD, VCR, DSS, PC, cable box, video camera, security camera, CD
10 jukebox, Home Control, laser disk, web TV, and video games.

Another important feature of the distribution unit or apparatus is the
5 active amplification the unit provides to the broadcast and CATV signals
received. Since the majority of the presently installed base of CATV is RG-59
15 coaxial cable with limited band width of approximately 500 MHz, this means
that the subscriber cannot receive television channel broadcast above channel
70. The distribution unit compensates for this by adding active gain which
20 amplifies the broadcast television signal by as much as 15 dB for the high end
channel frequencies.

These and other objects, features, and advantages of the present
invention will become more apparent in light of the following detailed
25 description of a best mode embodiment thereof, as illustrated in the
15 accompanying Drawing.

30 Brief Description of Drawing

Fig. 1 is an illustrative, somewhat figurative system block diagram of a
network embodiment of the present invention;

20 Fig. 2 is a schematic illustration of one embodiment of an element used
35 in the system embodiment of Fig. 1;

Fig. 3 is a schematic illustration of one embodiment of a component
used in the element embodiment of Fig. 2;

40 Fig. 4 is a schematic illustration of one embodiment of another
25 component used in the element embodiment of Fig. 2;

Fig. 5 is a schematic illustration of one embodiment of another element
used in the system embodiment of Fig. 1;

45 Fig. 6 is a schematic illustration of one embodiment of a component
used in the element embodiments of Figs. 5 and 10;

30 Fig. 7 is a schematic illustration of one embodiment of another
50 component used in the element embodiments of Figs. 5 and 10;

Fig. 8 is an illustrative top view of another element used in the system embodiment of Fig. 1;

Fig. 9 is an illustrative side view of the element of Fig. 8;

Fig. 10 is a schematic illustration of one embodiment of another element used in the system embodiment of Fig. 1;

Fig. 11 is a schematic of an alternate embodiment to that of the component embodiment illustrated in Fig. 2; and

Fig. 12 is a plan view of a mechanical layout of the embodiment of Fig. 11.

Best Mode for Carrying out the Invention

Referring now to Figure 1, the network 20 of the present invention provides the means by which a user/operator may command and control the performance and interoperability of various electronic devices within a building; typically a dwelling, such as a home, in which multiple electronic devices may be shared by users, or where multiple devices are capable of operating in a cooperative fashion in performing a commanded function. In the best mode embodiment the network is described in terms of a home network in which the different electronic devices within a home, including personal computers, audio receivers, VCRs, and television sets are present. Each of these devices perform a different utility but share a common functional characteristic in that they each provide an electrical signal output, and each are capable of responding to functional commands presented to them in an infrared signal format. As may become evident in the description to follow, the networked electronic devices in a home application may be generally grouped in a "consumer electronics" category, in which they perform either or both of an entertainment and a utility function. Where necessary, or possible, this description will distinguish these devices based on their intended function, but otherwise they will be referred to generally as "appliances."

As shown, the network 20 includes a distribution unit 22 which receives network signals at a plurality of network signal terminals 24 - 28. Each network

5 terminal is connected to one of a plurality of electrical signal conductors 30 - 33
comprising the network's communication plant. The conductors 30-33 are
10 routed through the building to individual wall plate connectors 34-37 in
different locations 38-41, such as rooms or other divided spaces in the home.

5 The communications plant is the network's means for exchanging network
signals between the distribution unit 22 and the appliances at locations 38 - 41.
15 The distribution unit 22 also receives, at a broadcast signal input 42, broadcast
signals, such as television programming signals, either broadband digital signals
and/or analog signals, received in a radio frequency (RF) modulated signal
10 format on lines 43 from broadcast signal sources, such as CATV services, or
20 antenna received broadcasts, and/or broadcast satellite services.

The multi-media nature of the present network is demonstrated by the
diversity of the appliances illustrated in Fig. 1 as being capable of
25 interconnection through the network. The locations 38, 39 each include digital
15 signal appliances, such as personal computers 44, 45, each of which may
themselves include peripheral equipment (not shown), such as printers or signal
storage (memory) devices. The location 40 includes a digital satellite signal
30 (DSS) receiver 46, a VCR 47, and a TV 48, with the location 41 having a video
game system 49 and TV 50. In addition to these electrically connected, i.e.
20 "wired" appliances, the network is also capable of receiving wireless
35 transmissions from "wireless appliances", such as a laptop computer 52, game
joystick 54, TV remote control 56, the network's own remote control 58, and a
wireless keyboard. The wireless transmissions are in both the infrared (IR) and
40 radio frequency (RF) frequency bands.

25 Functionally, the appliance may be broadly grouped as being either
digital signal appliances, such as computers and computer peripheral appliances,
and RF modulated audio and/or video signal appliances; generally "media"
45 appliances. The computer appliances communicate with each other in serial
digital signal format. The media appliances include either analog or digital
30 signal outputs. All of the appliance signals, together with the received broadcast
signals, are collectively transmitted through the network in a shared mode, in
50

5 one of three network allocated frequency bands. The bands include a data and
information band with a frequency range substantially from zero to 2.5 MHz, a
10 control and command band with a range substantially from 2.5 to 5.0 MHz, and
a broadcast services band substantially above 5.0 MHz.. The broadcast services
5 band is that defined by the United States Federal Communications Commission
(FCC) as extending from 5.0 MHz to 997.25 MHz. This includes a 5.0 to 42.0
15 MHz band dedicated to the Data Over Cable Service Interface Specification
(DOCSIS) for upstream digital signal communications between a subscriber
personal computer (PC) and the cable service provider's "head of network"
10 server, and the CATV broadcast band from 55.24 MHz (CATV channel 2) to
997.25 MHz (CATV channel 158). As known, the ultra high frequency (UHF)
television broadcast band, which extends from UHF channel 14 at 469.25 MHz
to UHF channel 69 at 801.25 MHz, is within the CATV spectrum.

25 Preferably, the conductors 30-33 have sufficient bandwidth to
15 accommodate the full CATV broadcast services band. In a best mode
embodiment the conductors 30-33 are RG-6 type coaxial conductors, preferably
the quad-shielded RG-6QS type, with 75 ohm characteristic impedance and a
30 bandwidth approaching 1.0 GHz. The RG-6 type cable is the present coaxial
standard for home installed CATV services in the 1990's. However, the present
20 network also accommodates existing cable service installations using the older,
lower bandwidth RG-59 type cable which was the CATV standard in the 1970's
35 and 1980's. The bandwidth of RG-59 cable is in the range of 500 MHz which is
below the frequency of CATV channel 65. As described in detail hereinafter
with respect to the distribution unit 22, the network provides active gain
40
25 compensation to the higher frequency channels to improve signal to noise ratio
and significantly extend the RG-59 bandwidth beyond CATV channel 80.

45 Referring now to Figure 2, which is a schematic block diagram of the
distribution unit 22. In the present network, a portion of each broadcast signal
spectrum, both CATV and UHF broadcast television, are reserved for internal
30 network use as modulation frequencies for the media signals transmitted
through the network. The media signals include both audio and video content as

5 may be available from the network connected appliances. In a best mode
embodiment, the reserved spectrum comprises the frequency band between UHF
Channels 15-30 (477.25 MHz through 567.25 MHz) and the CATV channels
10 65-80 (469.25 MHz through 559.25 MHz). It should be understood, however,
5 that the reserved band may be changed in both the reserved range and number of
reserved channels as deemed suitable for a given application by those skilled in
the art. The broadcast signals received at the distribution unit input terminal 42,
15 from line 43 which are within the reserved spectrums, are blocked by notch
filter 70, which has corner frequencies at 469.25 MHz and 567.25 MHz. The
10 notch filter 70 is a standard inductive-capacitive type known to those skilled in
the art for attenuating signal frequencies between the filter's lower and upper
frequency limits

As referred to hereinbefore, the present network includes active gain
25 shaping to extend the actual bandwidth of RG-59 coaxial cable to a higher
15 "virtual" limit by gain shaping the broadcast signals received from the notch
filter 70. The received broadcast signals have a nominal 15 dB signal
amplitude, however, as they propagate through an RG-59 cable the high
30 frequency channels are attenuated at a faster rate per lineal distance than the low
frequency channel. At a 100 foot distribution length a received 15 dB 600 MHz
20 signal is attenuated substantially to 0 dB. The active gain shaping counteracts
the high frequency attenuation and provides a usable signal-to-noise ratio signal
35 up to CATV channel 80 (approximately 600 MHz); which is beyond the
network reserved RF spectrum. In operation, broadband amplifier 72 provides
substantially 15 dB of amplification to the received broadcast signal. The
40 amplifier 72 is a known type RF amplifier, preferably in an integrated circuit
25 embodiment, such as the model RF 2317 high linearity RF amplifier
manufactured by RF Micro Devices, Inc., Greensboro, NC. The RF amplifier
45 has substantially flat gain from 50 MHz to 1000 MHz and a 75 ohm
characteristic input/output impedance, which matches the characteristic
30 impedance of the broadcast signal coaxial line 43 and the network's signal
conductors 30 - 33 (Fig. 1).

5 The amplified broadcast signals are presented on lines 74 to known type
slope equalization circuitry 76. As known to those skilled in the art, slope
equalization refers to an active circuit whose signal gain increases with
10 increasing signal frequencies within the amplifier's bandwidth. An active
5 amplifier, such as the RF Micro Devices, Inc. model RF 2317 RF amplifier is
adapted for use with an inductive-resistive output load which is functionally
15 placed in parallel with the amplifier voltage source (V_{cc}) feed L-R network.
This causes the amplifier output to be more severely loaded and the output
signal to be more severely attenuated at the lower frequency, thereby reducing
20 the gain provided by the broadband amplifier 72 at low frequencies. As the
signal frequency increases the output loading is reduced as the shunt inductor
reactance increases with frequency, thereby substantially reducing the
attenuation of the higher signal frequencies. The net effect of the combined RF
25 gain (amplifier 72) and slope equalization circuitry 76 is to extend the useable
circuit band width by providing a substantially constant 15 dB signal strength
15 over a frequency range up to 600 MHz. The gain shaped, notch filtered
broadcast signals (i.e. "conditioned broadcast signals") are presented at the
output of the slope equalization circuitry on lines 78.

The conditioned broadcast signals are presented on lines 78 to a balance
20 to unbalance mixer (BALUM) 80, which is a known type frequency mixer, such
as the TOKO model S617 dB-1010. The BALUM takes the output signal from
35 the slope equalization circuitry and converts it to 75 ohm impedance signals
which it provides on lines 82, 83 and 84. The signals on lines 82, 83 are
presented through high pass frequency filters 86, 87 to network terminals 24, 25
40 where they are distributed by conductors 30, 31 to the appliances in locations
25 38, 40 (Fig. 1). The high pass filters provide low impedance coupling of the
broadcast signals to the network terminals while also blocking the low
frequency signals that are simultaneously coupled to the terminals 24, 25
45 through low pass filters 88, 89 from the low frequency bus 90.

30 In a best mode embodiment the high pass frequency filters 86, 87 are
known type, balanced impedance, double Pi section, shunt inductor - series

5 capacitor type filters, as shown in Fig. 3. The inductor and capacitor component
values shown are illustrative of an acceptable combination of component values
which produce a balanced, substantially 75 ohm impedance, and a break
10 frequency (or -3 dB frequency) of substantially 5.0 MHz. It should be
5 understood, however, that various other combinations of component values may
be used as deemed suitable by those skilled in the art to achieve comparable
filter performance. Similarly, it must also be understood that the embodiment of
15 the filters 86, 87 is not limited to the filter implementation shown, but that
various other known forms or types of filters can be used, as may be deemed
10 suitable for the intended purpose by those skilled in the art.

20 Conversely, low pass frequency filters 88, 89, having a nominal -3dB
frequency filter corner frequency of 4.5 MHz, block the conditioned broadcast
signals from the BALUM 80 from being coupled onto the low frequency bus 90.
25 The low frequency bus 90 carries the low frequency data and information band
15 signals (0 - 2.5 MHz) and the command and control band signals (2.5 - 5.0
MHz), and couples these low frequency signals between each of the network
terminals through low pass filters, such as the filters 88, 89 associated with the
30 network terminals 24, 25. In a best mode embodiment the low pass filters 88,
89 are each balanced impedance, double Pi section, shunt capacitor - series
20 inductor type filters, as shown in Fig. 4. The inductive and capacitive values
shown in Fig. 4 are only illustrative of an acceptable combination of component
35 values which produce a balanced, substantially 75 ohm impedance, and a -3 dB
frequency of substantially 4.5 MHz. It should be understood, however, that
various other combinations of component values may be used as deemed
40 suitable by those skilled in the art to achieve comparable filter performance.
25 Similarly, it must also be understood that the embodiment of the filters 88, 89 is
not limited to the filter implementation shown, but that various other known
45 forms or types of filters can be used, as may be deemed suitable for the intended
purpose by those skilled in the art.

30 The remaining output of the BALUM 80, on line 84 is presented to a
cascaded, substantially similar type BALUM 92. The BALUM 92 couples the
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5 high frequency signals through high pass frequency filters 94, 95, which are
substantially similar to the high pass filters 86, 87, to the network terminals 26,
10 27 (Fig. 1). Similarly, low pass frequency filters 96, 97, which are substantially
similar to low pass filters 88, 89, block the high frequency broadcast signals
5 from passing through to the low frequency bus 90. Subject to signal power
losses of approximately -3dB per BALUM stage, successive BALUM stages
15 may be added as required to provide the necessary number of signal outputs in a
given network, thereby completing the distribution unit output at terminal 28.
Terminal 28 is similarly connected to high pass and low pass frequency filters
10 99, 100, which are each similar to the corresponding filter types described
hereinbefore.

One novel aspect of the present network is the "shared mode"
transmission of low frequency digital signals (0-5 MHz band) with RF broadcast
25 services signals (above 5 MHz) through common coaxial conductors. Each
individual coaxial conductor 30-33 supports bi-directional network signal
15 transmission, i.e. simultaneous upstream network signals (from appliances to
distribution unit 22) and downstream network signals (from distribution unit to
30 appliance). This includes the combined computer digital signals and the RF
modulated broadcast signals at frequencies approaching 1.0 Ghz, all of which
20 are transmitted in shared mode. As described hereinafter, the data and
information band signals (0-2.5 MHz) are transmitted at signal speeds of
35 substantially 1.0 Mbps and the command and control band signals at signal
speeds of substantially 125 Kbps. This is a distinct simplification of the CEBus
Standard which requires separate coax cables for upstream and downstream RF
40 signal transmission, and separates digital signal transmission onto a twisted pair
conductor. Although the present network's simplification of the
communications plant reduces the cost of installation for new construction in a
45 marginal way, it is its ability to be used with existing CATV installed wiring
that provides a substantially lower network cost for of existing wired homes.

30 The upstream network signals received by the distribution unit are
separated by the distribution unit into low frequency (0-5 MHz) digital signals
50

5 which are coupled through the low pass filters 88, 89 et al to the low frequency
bus 90, and high frequency (>5.0 MHz) RF signals which are coupled through
10 the high pass filters 86, 87 et al. to the BALUMS 80, 92 et al. The broadcast
signals are combined with the media signals in forming the downstream
5 network signal. Since the low frequency and high frequency signal transmission
are independent of each other, the low pass frequency filters provide a direct
15 bypass between the distribution unit's terminals 24 - 28 (Fig. 1) to maintain
digital signal speed. Similarly, the signal separation provided by the combined
low pass and high pass frequency filters allows for the flexibility of providing
10 "upstream" DOCSIS transmission (in the 5.0 to 42.0 MHz) through the
distribution unit. Although not a functional characteristic of the present
20 network embodiment, the distribution unit and the network interfaces may be
readily adapted through the use of bi-directional amplifiers as known to those
skilled in the art to provide upstream cable services.

15 The low frequency digital signal bands (0-5.0 MHz) and the high
frequency RF signal bands (> 5.0 MHz) require different interface apparatus
between their respective type appliances and the network. As stated
30 hereinbefore, in the embodiment of Fig. 1 two general categories of appliances
are shown; computer equipment and audio/video equipment. The audio and
20 video appliances which are generally dependent for their performance on RF
modulated signals are herein referred to generically as "media appliances", and
35 the computer related equipment are dependent on digital signal formats for
performance are referred to as "computer appliances". This is done for
convenience of description. Similarly, the signals related to the media
40 appliances (whether input or output signals) are referred to as media signals and
those associated with the computer appliances are referred to as computer
25 signals. The computer appliances interface with the network through a network
"PC modulator", such as the PC modulators 102, 104 of Fig. 1, and the media
appliances interface with the network through an "A/V (audio/video)
45 modulator", such as the A/V modulators 106-108 of Fig. 1.

50 As will be apparent in the following detailed description of the PC

5 modulator and the A/V modulator, they have common functional features. Each
type modulator receives the shared-mode, downstream network signals and
separates the low frequency digital signals (0 - 5.0 MHz) from the high
10 frequency RF signals (above 5.0 MHz), and further separates the data and
information signal (0 - 2.5 MHz) from the control and command signal (2.5 -
5.0 MHz). Each includes a microprocessor responsive to the computer signals
15 and each includes an RF modulator to provide for RF modulation of the media
signals at any of the 16 CATV and 16 UHF user reserved channel frequencies
for network distribution to other appliances.

10 Referring now to Figure 5, in a schematic block diagram of PC
modulator type apparatus 102, 104 the downstream network signal is received at
a coaxial connector terminal 110 and presented jointly through lines 112 to high
pass frequency filter 114 and low pass frequency filter 116. The filters 114 and
25 116 are substantially similar, respectively, to the high pass filters and low pass
filters 88, 89 described in detail hereinbefore with respect to Figures 3 and 4.
The high pass filter 114, alternately referred to as an RF modulated video signal
frequency filter, is a minimum third order filter, and it filters the downstream
30 RF broadcast television signals and RF modulated video signals onto line 118.
The low pass filter 116 segregates the low frequency digital signals onto lines
20 120.

35 The filtered RF modulated signals on the line 118 are presented through
a BALUM 122, such as the TOKO model S617 dB-1010, to the PC modulator's
video signal output 124. In a preferred embodiment the user PC connected to the
video output 124 is a broadcast enabled computer (e.g. 45, Fig. 1) which, with
40 appropriate receiver cards and supporting software allow the PC to display RF
broadcast signals or user video content provided on one of the reserved RF
spectrum channels.

45 The BALUM 122 is also connected for response to an RF modulator 126
which modulates the audio/video content provided on PC modulator terminals
30 128-130 from the media output of the user's computer 45. The modulator is of
a known type, such as the PHILIPS Model TDA8822 programmable RF

5 modulator, with a 4 MHz RF crystal oscillator 127. The modulator 126
generates an RF TV channel on one of the reserved spectrum channels from
baseband audio and video signals received at terminals 128-130, and two phase-
10 lock-loop (PLL) frequency synthesizers within the TDA8822 set the picture
5 carrier frequency and the sound subcarrier frequency to the selected channel.
The modulator provides the TV signal as a symmetrical output, and the
15 BALUM 122 converts it to an asymmetric 75 ohm impedance which it provides
back on lines 118, through high pass frequency filter 114 and the coaxial
connector 110 to the distribution unit.

10 The RF TV signal from the modulator 126 meets U. S. Federal
20 Communications Commission (FCC) requirements for broadcast TV channels;
namely a 6 MHz channel bandwidth with -30 dB suppression from peak carrier
level of any spurious frequency components more than 3 MHz outside the
25 channel limits. Peak carrier power is limited to less than 3 m Vrms, but more
15 than 1 Vrms, in 75-ohms, and the RF signal is hard-wired to the ultimate
receiver through the network cabling. The channel spectrum has a picture
carrier located 1.25 MHz from the lower band edge. This carrier is amplitude
30 modulated by the received video signal. For color signal, a second subcarrier is
added 3.58 MHz above the picture carrier. The aural (sound) carrier is 4.5 MHz
20 above the picture carrier and is frequency modulated with the audio signal to a
35 peak deviation of 26 KHz.

The RF modulator's performance, including the selected reserved RF
spectrum channel used for modulation, is controlled through command signals
received on an I²C multi-master bus 132 from a microprocessor 134. The
40 25 microprocessor 134 is of a known type, such as the ANCHOR Corporation
Model AN2131QC eight bit microprocessor, which sends commands in I²C bus
format to the modulator 126. Typically RF channel programming of the
45 modulator is achieved by having the processor 134 send an address byte and
four data bytes which initialize the picture carrier frequency, the sound
30 subcarrier frequency, and the video modulation depth. The picture carrier
50 frequency is that associated with the user selected RF TV channel of the

5 reserved RF spectrum, and the parametric data for each user reserved channels
is stored in an a non-volatile, re-writable memory storage device, such as an
EEPROM 135 connected to the I²C bus 132. The RF channel to be used is
10 selected by the user through a command input device to the processor, such as a
multi-position switch 136 having a set point for each reserved spectrum channel.
This channel selection switch 136 is used in conjunction with a band selection
15 switch 138 which, in a best mode embodiment, allows user selection of either
the CATV or the UHF channels of the reserved spectrum, as described
hereinbefore with respect to the distribution unit 22.

10 With respect to the low frequency digital signals of the downstream
network signals passed by filter 116 onto lines 120, low pass filter 140 couples
20 the 0 - 2.5 MHz data and information frequency band signal onto line 144 and
high pass filter 142 couples the 2.5 - 5.0 MHz command and control frequency
band signal onto line 146. The 0 - 2.5 MHz data is presented from line 144
25 through an interface impedance matching network comprising series resistor
143 connected to the signal input and output (I/O) ports of the microprocessor
134, and shunt resistor 145 connected from the series resistor 143 to signal
30 ground 147, which is the low voltage potential side of the PC modulator 102,
104 and of the computer appliance 45. The impedance matching network
20 provides an impedance value to signals propagating through filter 140 to the line
144, which approximates the characteristic impedance provided by the coaxial
35 cable, thereby providing a substantially balanced load impedance to the
unmodulated digital signals propagating in each direction, i.e. bi-directionally,
through the filter 140.

40 A preferred embodiment of the low pass filter 140, which is also referred
25 to as an unmodulated digital signal filter, is shown in Fig. 7 as a balanced
impedance, double Pi, shunt capacitor - series inductor type filter. The filter is a
45 minimum third order filter, and is preferably a fifth order filter. The inductive
and capacitive values shown are only illustrative of an acceptable combination
30 of component values which produce a substantially balanced 75 ohm impedance
and a -3 dB frequency of substantially 2.0 MHz. However, it should be

5 understood that various other combinations of component values may be used as
deemed suitable by those skilled in the art to achieve comparable filter
10 performance. Similarly, it must also be understood that the embodiment of the
low pass filter 140 is not limited to the filter implementation shown, but that
5 various other known forms or types of filters can be used, as may be deemed
suitable for the given application by those skilled in the art.

15 The high pass filter 142, which is also referred to as an electrical
command signal filter, is a balanced impedance, double Pi, shunt inductor -
series capacitor type filter, as shown in Fig. 6. As with low pass filter 140, the
10 inductive and capacitive values shown for the high pass filter 142 are only
illustrative of an acceptable combination of component values which produce a
20 substantially balanced, 75 ohm impedance and a -3 dB frequency of
substantially 2.5 MHz. It should again be understood that various other
combinations of component values may be used as deemed suitable by those
25 skilled in the art to achieve comparable filter performance. Similarly, it must
again also be understood that the embodiment of the high pass filter 142 is not
30 limited to the filter implementation shown, but that various other known forms
or types of filters can be used, as may be deemed suitable by those skilled in the
art.

20 In the best mode embodiment the signal form and protocol of the 0-2.5
35 MHz data and information band is frame formatted in accordance with the
universal serial bus (USB) standard. As known the USB standard defines a
combination architecture and protocol developed by a consortium of computer
40 and software manufacturing companies for the purpose of simplifying the
connection of peripheral equipment to a PC. It is presently incorporated in all
25 newly manufactured PCs. The object of USB is to provide a simpler "plug and
play" connection of printers, keyboards, and telephony adapters to the PC
45 without concern over I/O and DMA addresses. It also facilitates merger of the
PC with telephone devices for voice/data applications. Therefore, the network
30 facilitates USB communications between network connected USB PCs.

50 The PC modulator 102, 104 accomplishes this through the

5 microprocessor 134, which includes a USB connector 148 adapted to receive a
four wire USB cable 150 which carries a differential signal and power from the
10 user PC 45. The user PC 45 is considered the "host" under the USB's "host"
and "hub" protocol, and it initiates the exchange of information, in the form of a
5 transaction, with various peripheral equipment "hubs" connected to the network.
In these transactions the PC modulator, and in particular the microprocessor
15 134, appears as a compound device, not a hub. The microprocessor 134 relays
the transactional exchanges to the PC 45 over the cable 150 and to the addressed
device through the network.

10 As known, the USB standard requires a serial bit, frame formatted signal
with a full speed signaling bit rate of 12 Mbps. The frame is the basic quantum
of time for periodic data transfers, and they are issued every millisecond. The
frames are organized in packets and four types of packets comprise the basic
25 transaction units. These include "Start Of Frame" (SOF), "Token", "Data", and
15 "Handshake" packets. An SOF packet is 24 bits and includes a packet ID, an 11
bit framing number, and a 5 bit CRC. A Token packet is also 3 bytes long and
is used by the host controller to pass temporary control to each device
30 "endpoint", giving it the opportunity to send data or status information. A Data
packet always has a packet ID and a 16 bit CRC, and carries a variable length
20 data field that is dependent on the transfer type. A Handshake packet has only
an 8 bit packet ID and it is used to report the status of a data transfer for all but
35 isochronous transfers.

The USB also embodies a multi-master protocol in that the host or any
40 hub may initiate a transaction. For example, the host PC 45, may initiate a
25 transaction by sending a Token packet describing the type and direction of the
transaction to a second USB PC (e.g. the PC 44 in Fig. 1). The Token packet
includes the targeted device address, and the endpoint number. The addressed
45 device selects itself by decoding the address field. In the transaction data may
be transferred either from the host to the target device or from the target to the
30 host. The direction of data transfer is specified in the Token packet. The source
of the transaction then sends a Data Packet or indicates it has no data to transfer.
50

5 The destination in general responds with a Handshake Packet indicating if the transfer was successful.

10 As stated hereinbefore, the PC modulator facilitates the USB transactions by exchanging packets between the user PC 45 and the network, and the network transmits the packets within its transmission of network signals to each of the other network connected PC modulators. However, contrary to 15 the USB requirement for differential output drivers which require two conductors to send a signal, the network uses a single conductor coaxial cable to distribute the network signals. In addition USB drivers require signal 20 reflections from the end of the cable to fully switch on and off, and this generally limits usable USB cable lengths to substantially five meters. The network's communication plant coax, however, is much longer than 5 meters since it distributes the network signal throughout the house. Therefore, 25 although the microprocessor 134, through its USB connector 148 and cable 150, exchanges data in USB protocol with the user PC 45, it removes the USB frame and sends the data out to the network in an IrLAP protocol, as specified in a 30 USB to IR conversion standard developed by the Infrared Data Association (IrDA) and entitled: *Universal Serial Bus IrDA Bridge Device Definition*. This IrDA protocol is embedded in the USB protocol and the steps required to 35 transition from USB to IrDA are described in detail hereinafter. The IrDA standard is designed for half duplex signaling, which is appropriate for a single conductor cable such as a coax. Therefore, transaction sequencing between the microprocessor 134 and the user PC 45 is governed by the USB protocol while 40 transaction sequencing through the network is governed by the IrDA standard IrLAP protocol. 25

45 The microprocessor 134 forwards each IrDA packet to the network through lines 152 and an impedance matching/signal driver device, such as a field effect transistor (FET) or equivalent 154, to the line 144. The line 144 carries the bi-directional network signal exchange which includes the half 30 duplex exchange of upstream and downstream IrLAP frames. Each downstream IrLAP frame on the line 144 from the low pass filter 140 is presented to a signal 50

5 comparator 156, which provides bit state detection and conditioning of the data
signal and passes it through line 158 to the microprocessor 134. The processor
10 in turn relays the downstream transaction signal to the PC 45. Conversely, the
upstream serial IrLAP digital signals on line 144 from the FET 154 are "back-
5 flowed" through the low pass frequency filters 140, 116 to the coax connector
110. As described hereinbefore with respect to Figs. 5 and 7, the filters 116 and
15 140 are each balanced to present a substantially equal 75 ohm input impedance
to the bi-directional, forward flow and back flow transaction signals passing
through them.

10 As stated hereinbefore, in network of the present invention the signal
transmission format of the data and information band signals is a serial digital
bit signal transmitted in serial digital form, without signal modulation. These
20 non-modulated signals are transmitted through the coaxial conductors in a
shared mode with the RF broadcast services signals. In the disclosed network
25 embodiment the signal bit speed is substantially equal to 1.0 Mbps. This is a
selected value which may be considered a nominal signal speed for use in a
home network application, and which provides a conservative performance
30 balance between throughput requirements and signal noise considerations, such
as electromagnetic interference (EMI), associated with high switching speeds.
20 In the best mode embodiment the low pass filters within the signal transmission
path, including the filters 88 et seq, 116 and 140 provide sufficient dampening
35 of the digital signal ringing to accommodate higher bit speeds within the 0 to
2.5 MHz band.

40 The network's 2.5-5.0 MHz command and control band is used to
25 facilitate wireless infrared (IR) signal communications associated with the
network. Referring again to Fig. 1, the network's wireless IR communications
function includes the operator/user's control of network connected appliances
45 through an IR remote control device 56, or the user's IR wireless transfer of data
files and/or signal commands between a lap top computer 52 and network
30 connected PC 45, or between an IR joystick 54 and a game system 49, or
between a wireless keyboard and a network PC 44. As also known, the average
50

5 IR bandwidth has a signal speed from 32 KHz to 115 KHz. The disadvantages
are that it can be easily blocked and it has a limited transmission distance of 2 to
10 3 meters. The present network capitalizes on the IR advantages and minimizes
the disadvantages by distributing the IR command signals through the network
5 to the targeted appliance, thereby overcoming the limitations of obstacles and
distance. It does this by detecting IR signals emitted in any location serviced by
15 the network, converting the detected IR signal to a modulated signal which is
routed to all network locations, and demodulating the distributed signal back to
IR for detection by the targeted appliance.

10 There is no standard performance specification for legacy consumer IR
technology, however, with PC manufacturers using IrDA (Infrared Data
Association) IR transceivers for wireless PC communications, and IR
transceiver manufactures adding support for legacy consumer IR in their IrDA
25 transceivers, an industry task group is developing guidelines for interfacing
IrDA and legacy consumer IR devices with the USB protocol. These guidelines,
15 entitled: *Universal Serial Bus IrDA Bridge Device Definition*, are published in a
preliminary Revision 0.9, dated July 6, 1998, which is herein incorporated by
reference. The guidelines functionally define an IrDA Bridge device capable of
30 interfacing legacy consumer IR technology and IrDA wireless LAN technology
with a host USB device, such as user PC 45 shown connected to the network in
20 Figs. 1, 4.

As more fully described hereinafter, emitted IR signals within a network
site, either consumer IR or IrDA protocol, are detected by IR detectors disposed
40 within the PC modulators (102, 104, Figs. 1, 4) and A/V modulators (106-108,
25 Fig. 1). The detected IR signal content, which may include the identity of the
target appliance as well as the data or command content within a "payload"
portion of the signals serial bit frame, is modulated to an electrical signal
45 equivalent, formatted in accordance with the above cited guidelines, and
distributed as part of the upstream network signals through the communications
plant 36 and distribution unit 22 to each of the network's other PC modulators
30 and A/V modulators. Each of the receiving PC and A/V modulators

5 demodulates the distributed signal to its IR signal equivalent and transmits it
through an IR emitter into the spatial location. A targeted appliance which is
within the field-of-view of the emitted IR signal can respond to the command by
10 performing the commanded task, such as turning on a television or downloading
5 files from a laptop computer.

Referring again to Fig. 5, the PC modulator includes a known type IR
15 transceiver (i.e. a combination IR emitter-detector) 160, such as the Hewlett
Packard IrDA Infrared Transceiver Model HSDL-1001 "Infrared IrDA®
Compliant Transceiver", which is connected through lines 162 and a telephone
10 type jack (not shown) to an IR/IrDA bridge device 164. In a best mode
20 embodiment the IR emitter-detector combination comprises dual emitters and
dual detectors, each positioned to cover complimentary areas of the modulator's
field-of-view, thereby minimizing the IR obstacle and transmission distance
25 limitations. Figs. 8 and 9 illustrate a plan view and side elevation view,
15 respectively, of a suitable IR emitter-detector configuration for use with the
present network.

Referring simultaneously to Figs. 8, 9, an IR emitter-detector
30 combination 160 includes a housing portion 166 (shown in a breakaway side
elevation in Fig. 9 to facilitate the description) connected to a mounting base
20 168. The base 168 is adapted for placement beneath an appliance 170 (shown in
phantom) in a manner which positions the housing portion in proximity to the
35 IR detector 172 of the appliance. The housing includes a backplane surface 174
with a mounted first IR emitter 176, and it includes a front surface 178 with: a
40 mounted second IR emitter 180, first and second mounted detectors 182, 184,
25 and a light emitting diode (LED) 186. The backplane is displaced at an obtuse
angle, nominally 135 degrees, from the plane of the mounting base to position
the network emitter 176 substantially in a line of sight orientation with the IR
45 detector 172 of the appliance 170. Similarly, network emitter 180, together with
the network IR detectors 182, 184 provide forward field-of-view coverage. The
30 detectors 182, 184 are positioned within the housing to provide maximum field
50 coverage. The LED 186, which is electrically connected for response to the RF

5 modulator 126 (Fig. 4), flashes when IR signals are being received by detectors 182, 184.

10 Referring back again to Fig. 5, a detected infrared transmission on the line 162 is in a frame format which includes address and control bytes, as well
5 as optional data, in a "payload" portion of the frame, separate from other overhead bytes. The IR/IrDA bridge device 164, exchanges data between the IR
15 emitter-detector-160 and the microprocessor 134. The IR/IrDA bridge strips out the payload portion of the IR detector frame, preserving the address and control
bytes as well as any optional data content, and converts it into one or more
20 IrLAP formatted frames for presentation to the modulator / demodulator 188 on a bandwidth available basis. The modulator / demodulator or frequency
modulates the converted signal content at a selected modulation frequency
within the 2.5 to 5.0 Mhz command and control frequency band. In a best mode
25 embodiment, the modulation frequency is substantially equal to 3.0 Mhz.

15 The modulated converted signal is provided by the modulator/demodulator 188 through lines 146 to the high pass filter 142. The
modulated IR signal is back-flowed through the filter 146 as well as the low
30 pass filter 116 to the coax connector 110, and transferred in shared mode with the RF broadcast service signals through the communications plant 36 (Fig. 1)
20 to the distribution unit 22. From there it is distributed downstream to each of the other modulators connected to the network. The downstream command and
35 control signal is passed through low pass filter 116 and high pass filter 142 to the modulator/demodulator 188, which demodulates the signal, passes it to the
IR/IrDA bridge device which reformats the payload into an IR frame format and
40 passes it to the IR emitter portion 176, 180 (Fig. 6 A, 6B) of the IR emitter-
25 detector combination (i.e. transceiver) 160. The IR emitter broadcasts the signal into the room.

45 With the present network adapted for use with both consumer IR devices and IrDA standard devices, the user is provided with a range of options in terms
30 of wireless control functions and data communications. While legacy consumer
50 IR devices only transmit and receive IR in the 32-58 KHz range, the IrDa

transceiver 160 is capable of receiving and transmitting infrared in excess of 150 KHz. This means that IR video game controllers, infrared headphones, and laptop computers can communicate through the IrDA transceiver from any room of the house, with speeds up to 1 Mbps. This versatile IR command feature allows nearly unlimited flexibility in user IR command of any appliance on the network, no matter where the appliance is located. This, together with the availability of user selectable channels within the reserved RF spectrum, gives the network user a virtual broadcast studio.

The power of the present network in terms of its versatility and three band spectrum, can be further enhanced with the connection of at least one broadcast enabled PC connected to the network through a PC modulator as described hereinabove with respect to Fig. 5. As may be known, a broadcast enabled PC means a PC that has a TV tuner card and a composite video output which allows the PC user to watch television broadcast video on the PC monitor. MICROSOFT WINDOWS 98 (MICROSOFT and WINDOWS 98 are trademarks of the Microsoft Corporation) includes TV viewer software.

The use of a broadcast enabled PC is recommended, but optional. However, USB support is required to attach a PC to the network. The USB based PC must also have installed either MICROSOFT WINDOWS 98 or MICROSOFT WINDOWS 95 (build 950B). With a USB PC connected to the network through a PC modulator, the PC video output can be displayed on, and functionally controlled from, any TV in the house. This versatility makes the computer all the more important in that it allows the display of DVD movies, the internet, 3-D games and more all on a large screen television. The system also allows a laptop computer to interface with the PC in any room in the house in which the IrDA transceiver is located on a PC modulator or A/V modulator, as described in detail hereinafter. The result is that the computer can be a central control station for all of the components attached to the network.

As an example of the flexibility in controlling appliance performance, with the present network it is possible to have the user's PC, such as the PC 45 in location 39 (Fig. 1) display menu choices, in terms of network appliance

5 features/selection, on the TV 48 in location 40. This occurs through user input
by the network remote control device 58 (Fig. 1) which is a combination
10 wireless infrared (IR) and wireless RF unit which allows for direct
communication between user and the network connected PC through an "on-
5 screen," "user-friendly" interface technology..

The PC modulator 102, 104 of Fig. 5 includes an RF receiver tuned to an
15 assigned RF control frequency; preferably a frequency above 900 MHz to
prevent electromagnetic interference with the broadcast service signals. A
typical standard frequency is 916 MHz. The remote control 58 includes: a
20 "power button" that turns the various network appliances on and off, a "menu
button" that causes application specific menus to be displayed on the user PC
display, or any TV display connected to the network, and a "help button" that
causes application specific help menus to be displayed. The remote also
25 includes directional capabilities, similar to keyboard arrow keys, and a "select
15 button" that functions like the keyboard enter key.

User actuation of the menu button causes the remote control to
30 substantially simultaneously emit a 916 MHz RF command signal and an IR
code signal. In the PC modulator the RF command signal is forwarded from
receiver 190 to microprocessor 134 and, through USB connector 148, to the
20 user's PC 45. The user PC functions as the network server, and USB host
35 computer. At the same time the network modulator at the user location detects
the remote control IR code signal and notifies the host PC of the user location
over the control and command band (2.5 - 5.0 MHz). The PC responds by
changing the TV channel at the user location to a PC Menu channel selected
40 from among the reserved RF spectrum channels. The user may then select a
25 particular menu listed appliance, such as a VCR, and the user selection is
forwarded to the PC through the command and control band. The PC responds
45 by sending an IR command through the command and control band to the local
TV to change the TV channel to that assigned to the particular VCR.

30 The user may use the remote arrow keys to move a pointer which is
50 visible on the TV to "point and click" on a menu listed selection for the VCR or,

alternately, to select a "next menu" which allows the user to move from menu to menu. If the user selects a VCR selection, such as PLAY, the user PC sends the consumer IR code over the command and control band (2.5 to 5 megahertz) to actuate the VCR PLAY function. A look-up table stored in memory in the PC has the consumer IR codes of the user listed appliances, which were entered during the network setup procedure, at which time the consumer was asked what model VCR he has and which room the VCR is located. This allows the PC to build menus that are specific to every network application.

The IrDa protocol is used for networking computers and printers. IrDa is imbedded in a USB packet and sent through the USB cable to the PC modulator. The PC also sends consumer infrared command through the USB port to the PC modulator. The PC modulator removes IRDA packets and sends them over the 0 to 2.5 megahertz data highway. The Consumer IR signals are removed from the USB packet, then modulated to 3 MHz and sent to the IR pipe on the 2.5 to 5 megahertz band. As an example of the utility provided by this infrared channel, a laptop computer could download files on the infrared channel accessible through a TV in one room to a desktop PC located in another room.

Referring again to Fig. 1, site locations 40, 41 each include various types of media appliances, including a DSS 46, VCR 47, and a TV 48 in location 40 and a game system 49 and a TV 50 in location 41. As should be understood, the media appliances shown are merely illustrative of the various consumer type devices which may be found in a home or other living environment. The network 20 interfaces with the media appliances through an A/V modulator of the type shown in Figure 10. The A/V modulator is substantially similar to the PC modulator 102, 104 described hereinbefore with respect to Fig. 5.

Referring now to Figure 10, in a detailed block diagram of the audio/video (A/V) modulator 108 connected to the audio/video source 49 and TV 50 media appliances of Fig. 1 the downstream network signal on line 200 from the wall plate connector 37 are received at the modulators coaxial cable connector 201 and conducted through lines 202 to a high pass frequency filter 204, which is also referred to as an RF modulated signal filter, and low pass

5 frequency filter 206. The filters 204, 206 are substantially similar to high pass
filters 86, 87 and low pass filters 88, 89 described hereinbefore with respect to
10 Figs. 3, 4, respectively, and they separate the received RF broadcast television
signals and RF modulated video signals onto line 208, and the low frequency
5 signals, including the unmodulated digital signals and electrical command
signals, onto lines 210.

15 The downstream broadcast signals on line 208 are presented through a
BALUM 212, such as the TOKO model S617 dB-1010, and through lines 214
to the A/V modulator's media signal output 216. The media signal output is
10 connected by a coaxial cable 217 to the TV 50. The BALUM 202 is also
connected to the modulated signal output of an RF modulator 218 which
modulates the audio/video content provided on the A/V modulator 108 input
terminals 220-222 from the audio/video source 49. The modulator 218 may be
25 of the same type as that used in the PC modulator, namely the PHILIPS Model
15 TDA 8822 Programmable RF Modulator with a 4 Mhz RF crystal oscillator
224. The modulator 218 generates an RF TV channel on one of the reserved RF
spectrum channels from baseband audio and video signals received at the
30 terminals 220-222, and two phase-lock-loop (PLL) frequency synthesizers
within the TDA 8822 set the picture carrier frequency and the sound subcarrier
20 frequency to the selected channel. The modulator provides the TV signal as a
symmetrical output, and the BALUM 212 converts it to an asymmetric 75 Ohm
35 impedance which it provides as an upstream media signal. This media signal is
presented on lines 208 back through the high pass frequency filter 204 to the
coaxial connector 201 and to the distribution unit (22, Fig. 1).

40 The RF TV channel signal from the modulator 218 meets FCC
25 requirements for broadcast TV channels as described hereinbefore in detail with
respect to the PC modulator (Fig. 5). A microprocessor 226, such as the Phillips
45 Model S83C751 eight bit microprocessor, provides performance control of the
modulator 218 through an I²C multi-master bus 228. Typical channel
30 programming of the modulator 218 is achieved by having the processor 226
send an address byte and four data bytes which initialize the picture carrier
50

5 frequency, the sound subcarrier frequency, and the video modulation depth. The
parametric data for each of the user reserved channels is stored in a non-volatile
10 re-writable memory storage device, such as an EEPROM 230 which is
accessible through the I²C bus 228. The user selects the RF TV channel to be
5 used through a command input device to the processor 226, such as a multi-
position channel selection switch 232 having a set point for each reserved
15 spectrum channel. This channel selection switch 232 is used in conjunction
with a band selection switch 234 which, in a best mode embodiment, elects
either the CATV or the UHF channels of the reserved spectrum.

10 The downstream low frequency digital signals from the low pass filter
206 on lines 210 are separated by low pass filter 236 and high pass filter 238,
20 respectively, into the 0 - 2.5 MHz data and information band signal on line 240
and the 2.5 - 5.0 MHz command and control band signal onto line 242. The 0 -
25 2.5 MHz data is presented from line 240 through an interface impedance
15 matching network comprising series resistor 239 connected to the signal input
and output (I/O) ports of the microprocessor 226, and shunt resistor 241
30 connected from the series resistor 239 to signal ground 243, which is the low
voltage potential side of the A/V modulator 108. The impedance matching
network provides an impedance value to signals propagating through filter 236
20 to the line 240, which approximates the characteristic impedance provided by
35 the coaxial cable, thereby providing a substantially balanced load impedance to
the unmodulated digital signals propagating in each direction, i.e. bi-
directionally, through the filter 236.

40 The low pass and high pass filters 236, 238 are substantially identical to
25 the low pass and high pass filters 140, 142 of the PC modulator, which are
shown in preferred embodiments in Figs. 6, 7. As described hereinbefore with
respect to the PC modulator of Fig. 5, both of these band signals are transmitted
45 through the network in the IrLAP protocol specified in the referenced IrDA
Universal Serial Bus IrDA Bridge Device Definition, and which is embedded in
30 the USB protocol. This is made necessary by the single conductor coaxial cable
50 used for the network communications plant; the USB protocol requires a

5 differential (two conductor) transmission mode. Alternatively, if two conductor
wire is used instead of coaxial cable the USB standard could be used for intra-
network transmissions. As with the USB standard the IrLAP is designed for
10 half duplex signaling, which is appropriate for a single conductor cable.

5 The microprocessor 226 forwards each upstream IrDA packet to lines
240 which carries the bi-directional, half duplex exchange of upstream and
downstream IrLAP frames. Each downstream IrLAP frame is "forward passed"
15 through the low pass filter 236 to the microprocessor 226 and each upstream
IrLAP frame from the microprocessor is "back-flowed" through the low pass
20 filters 236 and 206 to the coax connector 200. As described hereinbefore with
respect to Figs. 5 and 7, the filters 116 and 140 are each balanced to present a
substantially equal 75 ohm input impedance to the bi-directional, forward flow
and back flow signals passing through them. As stated hereinbefore with
25 respect to the PC modulator of Fig. 5, these are serial digital bit signals
15 transmitted in serial digital form, without signal modulation, and they are
transmitted through the network conductors in shared mode with the RF
broadcast services signals. In a best mode embodiment the signal bit speed is
30 substantially equal to 1.0 Mbps.

The A/V modulator 108 processes the network 2.5-5.0 MHz command
20 and control band signals, i.e., the "IR band" in substantially the same manner as
the PC modulator of Fig. 5. It also includes a combination IR emitter-detector
35 244 which is similar to the dual IR emitter-detector combination 160 of the PC
modulator described hereinbefore with respect to Figs. 8,9, and which is
connected through lines 246 and a telephone type jack (not shown) to an
40 25 IR/IrDA bridge device 248. The dual emitters/ detectors cover complimentary
areas of the A/V modulator's field-of-view within its location (e.g. 41 of Fig. 1)
thereby minimizing the IR obstacle and transmission distance limitations. The
45 IR/IrDA bridge 248 strips out the payload portion of all IR signal frames
detected by the combination 244, preserving the address and control bytes as
30 well as any optional data content, and converts it into one or more IrLAP
formatted frames for presentation to a modulator / demodulator 250 on a
50

5 bandwidth available basis. As with the modulator / demodulator 188 of Fig. 5,
the modulator / demodulator 250 frequency modulates the converted signal
10 content at a preferred modulation frequency of substantially 3.0 Mhz. However,
as stated hereinbefore, the modulation frequency may be any selected frequency
5 within the command and control band 8.25-5.0 Mhz.

The modulated IR signal is presented through lines 242 and backflowed
15 through filter 238 to the line 210, where is combined with the upstream data and
information band signal from the filter 236. The combined low frequency
signals are then backflowed through filter 206 to the coax connector 201 and
20 combined with the RF modulated media signals and coupled through the
communications plant 36 (Fig. 1) to the distribution unit 22. From there it is
distributed downstream to each of the other modulators connected to the
network. The downstream command and control band signal is passed through
25 low pass filter 206 and high pass filter 238 to the modulator/demodulator 250,
which demodulates the signal, passes it to the IR/IrDA bridge device 248 which
reformats the payload into an IR frame format and passes it to the IR emitter
portion 176, 180 (Fig. 6 A, 6B) of the IR emitter-detector combination
30 (transceiver) 244. The IR emitter broadcasts the signal into the room.

The distribution unit 22 (Fig. 2) may also be provided in an alternate
20 embodiment which significantly reduces the unit's parts count, and cost, in
certain network applications. These applications include networks which may
experience some degree of variation in the network load impedance and/or
35 networks in which the cable run length approach the quarter wavelength
distance of the baseband signal frequency, which is 1 Mhz (with a quarter
40 wavelength of approximately 246 feet). Under these conditions, changes in load
25 impedance due open network ports (i.e. unterminated ports whose infinite
impedance significantly alters the equivalent load impedance, which is
45 nominally the parallel resistance equivalent of each cable's characteristic
impedance.

30 In other words, in the illustrated embodiment of five port connectors, the
load impedance from 1 port connected to all five ports connected ranges from
50

5 75 to 37.5 to 25 to 18.75 to 15 ohms. If the unit output signal is scaled to an
average 25 ohm load impedance the signal amplitude may change by + 50% (for
10 75 ohms) to - 25% (for 15 ohms). Since the BALUMS cannot maintain
impedance isolation under those conditions and since the high pass and low pass
5 filters in the network modulator provide sufficient signal separation, it may be
deemed suitable by those skilled in the art to remove the BALUMs and unit
15 filters to save cost. The alternate embodiment of the distribution, therefore,
removes the BALUMS (80, 92) the high pass and low pass filters (86-89, 94-97,
and 99, 100), and combines the high frequency and low frequency busses (78,
10 90) into a common port bus.

Referring now to Fig. 11, the alternative embodiment distribution unit
22A includes the same elements as the prior embodiment within the RF
broadcast signal path. This includes the CATV and other broadcast source
25 signals received at the distribution unit connector 42 from the line 43 (Fig. 1).
15 This path includes the notch filter 70, broadband amplifier 72 and slope
equalization circuitry 76, which perform the same functions described in detail
hereinbefore with respect to Fig. 2. The change occurs in the elements and bus
30 circuitry associated with the network ports 24-28. As shown in Fig. 11, each of
the network ports is coupled through associated distribution unit impedance
20 matching networks 270-274, each connected between the distribution unit signal
bus 78A and the individual output ports 24-28. The distribution unit impedance
35 matching networks, as shown by the circuit 270, comprise three parallel paths,
including a series resistor/inductor path 276, a series resistor/capacitor path 278,
and a capacitor path 280. The purpose of the impedance circuits is to provide
40 impedance matching between the signal bus and the characteristic impedance of
25 the coaxial cables connected to each output port. In addition, with the loss of
signal isolation otherwise provided by the BALUMS and the frequency filters of
45 the Fig. 2 embodiment, the distribution unit impedance matching networks
further provide short circuit protection of the network in the event of a short to
30 ground of an output port or its connected cable.

Another consideration of the alternative embodiment of Fig. 11 is the

5 signal path length of each port connector; this is the physical length from the
common port bus 78A to each of the ports 24-28. This is of concern with
10 respect to signal reflections occurring at an unterminated port. This signal path
length is preferably less than a quarter wavelength of the network's highest
5 frequency signal to prevent signal reflections occurring at an unterminated port
at the network's highest operating frequencies. These reflections may cause
15 signal interference with both the broadband and baseband signal frequencies.
In the present embodiment, with the CATV broadcast signal frequencies
approaching 1 Gigahertz (at or about 900 Mhz), the quarter wavelength of a 1
10 Ghz signal is approximately 1.3 inches.

20 Referring now to Fig. 12, which is a plan view of one physical
embodiment of an illustrative of housing configuration 282 for the distribution
unit 22A. The purpose of Fig. 12 is simply to illustrate one exemplary
25 configuration of the common port bus which limits the bus to port signal path
distance to a value less than the critical quarter wavelength value. In Fig. 12 the
distribution unit housing is shown to include a "hub" profile 284 in one portion
30 of the housing's overall housing profile. The hub encloses a "star configured
common port bus" 286, having port signal paths 288-292 radiating from the bus
center. Each port signal path length is approximately equal in length, and each
20 such signal path length is less than the critical length of approximately 1.3
35 inches

40 Although the invention has been shown and described with respect to a
best mode embodiment thereof, it should be understood by those skilled in the
art that various changes, omissions, and additions may be made to the form and
25 detail of the disclosed embodiment without departing from the spirit and scope
of the invention, as recited in the following claims.

Claims

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Claims**We claim:**

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1. The method of exchanging unmodulated digital signals between digital signal apparatus, including computers, over a single conductor coaxial cable simultaneously with broadband transmission of RF modulated video signals

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5 between video signal apparatus over the same cable, the video apparatus including one or more video signal sources and one or more video signal receivers, the coaxial cable having a cable characteristic impedance, the method comprising:

20

establishing a plurality of signal frequency channels, including an RF video signal channel and a PC digital signal channel, each frequency channel having a different frequency range;

25

connecting the signal input and output (I/O) ports of each digital signal apparatus to a first terminal of a digital signal frequency filter, a second terminal of which is connected to the coaxial cable, said digital signal frequency filter having a frequency passband which is substantially equal to the frequency range of said PC digital signal channel, said digital signal frequency filter providing a substantially equal filter characteristic impedance to unmodulated digital signals exchanged bi-directionally, at a signal bit speed, between said first terminal and said second terminal; and

30

20 connecting each RF modulated video signal apparatus to the cable through an RF video signal frequency filter having a frequency passband which is substantially equal to the frequency range of said RF video signal channel, said RF video signal frequency filter providing a substantially equal filter characteristic impedance to RF modulated video signals propagating bi-directionally therethrough between the RF modulated video signal apparatus and the cable.

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2. The method of claim 1; wherein said step of establishing further includes the step of assigning a lower range of signal frequency values to said PC digital

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5
30 signal channel than to said RF video signal channel.

3. The method of claim 1, wherein said first step of connecting further includes the step of:

10 inserting a impedance matching network between the digital signal apparatus signal I/O ports and said first terminal of said digital signal frequency
5 filter, said impedance matching network providing a terminating impedance value at said first terminal which approximates the cable characteristic
15 impedance provided by the coaxial cable to said second terminal, thereby providing said substantially equal filter characteristic impedance to unmodulated digital signals exchanged bi-directionally, at a signal bit speed,
20 through said digital signal frequency filter.

4. The method of claim 3, wherein said step of inserting further includes:

25 providing said impedance matching network as a series resistor functionally connected at first and second ends thereof to said first terminal and
5 to the digital signal apparatus signal I/O ports, respectively, said series resistor further connected at said second end through a shunt resistor to the low voltage
30 potential signal reference of the digital signal apparatus signal I/O ports.

35 5. The method of claim 4, wherein said shunt resistor has a shunt impedance value which is substantially equal to the value of the cable characteristic impedance, and wherein said series resistor has a series impedance
5 value which is in the range of from one third to two thirds of said shunt impedance value.
40

45 6. The method of claim 1, wherein said digital signal frequency filter is at least a third order filter.

50 7. The method of claim 1, wherein said RF video signal frequency filter is at least a third order filter.

5
8. The method of claim 1, wherein said digital signal frequency filter is at least a fifth order filter.

10
9. The method of claim 2, wherein said PC digital signal channel frequency range is substantially from zero hertz to 2.5 megahertz and said RF video signal channel frequency range is greater than five megahertz.

15
10. The method of claim 3, wherein said signal bit speed of the unmodulated digital signal is a minimum of substantially 1.0 Mbps.

20
11. The method of claim 5, wherein said series impedance value is selected at a value within said range to minimize interference of the unmodulated digital signals with the RF modulated video signals.

25
12. The method of exchanging unmodulated digital signals between digital signal apparatus over a single conductor coaxial cable simultaneously with broadband transmission of RF modulated video signals between video signal
30
5 apparatus over the same cable, the video apparatus including one or more video signal sources and one or more video signal receivers, the coaxial cable having a cable characteristic impedance, the method comprising:

35
establishing a plurality of signal frequency channels, including a PC digital signal channel having a frequency range substantially from zero hertz to
10 2.5 megahertz and an RF video signal channel having a frequency range substantially at five megahertz and above;

40
connecting the signal input and output (I/O) ports of each digital signal apparatus through an impedance matching network to a first terminal of a digital signal frequency filter, a second terminal of which is connected to the coaxial
45
15 cable, said digital signal frequency filter having a frequency passband which is substantially equal to the frequency range of said PC digital signal channel to provide for bi-directional exchange of unmodulated digital signals between the
50
coaxial cable and the I/O ports of the digital signal apparatus, said impedance

5
20 matching network providing a terminating impedance value at said first terminal
which approximates the cable characteristic impedance provided by the coaxial
10 cable to said second terminal, to provide said bi-directional exchange of
unmodulated digital signals at a minimum signal bit speed of substantially 1.0
Mbps; and

15 connecting each RF modulated video signal apparatus to the cable
25 through an RF video signal frequency filter having a frequency passband which
is substantially equal to the frequency range of said RF video signal channel,
said RF video signal frequency filter providing a substantially equal filter
20 characteristic impedance to RF modulated video signals propagating bi-
directionally therethrough between the RF modulated video signal apparatus and
30 the cable.

25 13. Apparatus for exchanging unmodulated digital signals between digital
signal apparatus, including computers, over a single conductor coaxial cable
simultaneously with broadband transmission of RF modulated video signals
5 between video signal apparatus over the same cable, the video apparatus
30 including one or more video signal sources and one or more video signal
receivers, the coaxial cable having a cable characteristic impedance, the
apparatus comprising:

35 a plurality of digital signal frequency filters, one each associated with
10 each digital signal apparatus, each said digital signal frequency filter having a
first terminal adapted for signal connection to the signal input and output (I/O)
40 ports of the associated digital signal apparatus and having a second terminal
adapted for signal connection to the coaxial cable, each said digital signal
frequency filter having a frequency passband suitable to pass the unmodulated
15 digital signals therethrough, bi-directionally between the digital signal apparatus
and the coaxial cable, at a selected signal bit speed and at a substantially equal,
45 bi-directional filter characteristic impedance; and

a plurality of RF video signal frequency filters, one each associated with
50 each RF modulated video signal apparatus, each said RF video signal frequency

5
20 filter having a first terminal adapted for signal connection to the signal I/O ports
of the associated RF modulated video signal apparatus and having a second
10 terminal adapted for signal connection to the coaxial cable, said RF video signal
frequency filters having a frequency passband suitable to pass the RF modulated
video signals therethrough, bi-directionally between the video signal apparatus
25 and the coaxial cable.

15
14. The apparatus of claim 13; wherein the passband of said RF modulated
video signal filter is at a higher frequency spectrum than the passband of said
20 digital signal filter.

15. The apparatus of claim 13, further comprising:
a plurality of impedance matching networks, one each inserted between
25 the digital signal apparatus signal I/O ports and said first terminal of said digital
signal frequency filter, said impedance matching network providing a
5 terminating impedance value at said first terminal which approximates the cable
characteristic impedance provided by the coaxial cable to said second terminal,
30 thereby providing said substantially equal filter characteristic impedance to
unmodulated digital signals exchanged bi-directionally, at a signal bit speed,
10 through said digital signal frequency filter.

35
16. The apparatus of claim 15, wherein each said impedance matching
network comprises:

40 a series resistor functionally connected at first and second sides thereof
5 to said first terminal and to the digital signal apparatus signal I/O ports,
respectively, said series resistor also connected at said second side through a
shunt resistor to the low voltage potential reference of the digital signal
45 apparatus signal I/O ports.

17. The apparatus of claim 16, wherein said shunt resistor has a shunt
impedance value which is substantially equal to the value of the cable
50 characteristic impedance, and wherein said series resistor has a series impedance

5 value which is in the range of from one third to two thirds of said shunt
5 impedance value.

10 18. The apparatus of claim 13, wherein said digital signal frequency filter is
at least a third order filter.

15 19. The apparatus of claim 13, wherein said RF video signal frequency filter
is at least a third order filter.

20 20. The apparatus of claim 13, wherein said digital signal frequency filter is
at least a fifth order filter.

25 21. The apparatus of claim 14, wherein the frequency passband of said
digital signal filter is substantially from zero hertz to 2.5 megahertz and the
frequency passband of said RF video signal filter is greater than five megahertz.

30 22. The apparatus of claim 15, wherein said signal bit speed of the
unmodulated digital signal is a minimum of substantially 1.0 Mbps.

35 23. The apparatus of claim 17, wherein said series impedance value is
selected at a value within said range to minimize digital signal interference with
the RF modulated video signals.

40 24. Apparatus for exchanging unmodulated digital signals between digital
signal apparatus over a single conductor coaxial cable simultaneously with
broadband transmission of RF modulated video signals between video signal
5 apparatus over the same cable, the video apparatus including one or more video
45 signal sources and one or more video signal receivers, the coaxial cable having a
cable characteristic impedance, the apparatus comprising:

a plurality of digital signal frequency filters, one each associated with
50 each digital signal apparatus, each said digital signal frequency filter having a

5
10 first terminal adapted for signal connection through a impedance matching
network to the signal input and output (I/O) ports of the associated digital signal
10 apparatus and having a second terminal adapted for signal connection to the
coaxial cable, each said digital signal frequency filter having a frequency
passband substantially from zero hertz to 2.5 megahertz so as to pass the
15 unmodulated digital signals bi-directionally therethrough, between said first and
second terminals;

15
a plurality of impedance matching networks, one each inserted between
the signal I/O ports of an associated digital signal apparatus and said first
terminal of an associated one of said digital signal frequency filters, said
20 impedance matching network providing a terminating impedance value at said
first terminal of said associated digital signal frequency filter which
approximates the cable characteristic impedance provided to said second
25 terminal of said filter, to provide a substantially balanced filter characteristic
impedance to unmodulated digital signals exchanged bi-directionally through
said digital signal frequency filter at a minimum signal bit speed of substantially
25 1.0 Mbps; and

30
a plurality of RF video signal frequency filters, one each associated with
each RF modulated video signal apparatus, each said RF video signal frequency
filter having a first terminal adapted for signal connection to the signal I/O ports
35 of the associated RF modulated video signal apparatus and having a second
terminal adapted for signal connection to the coaxial cable, said RF video signal
frequency filters having a frequency passband beginning substantially at five
40 megahertz and increasing to an upper frequency limit suitable to pass the RF
modulated video signals bi-directionally therethrough, between the video signal
35 apparatus and the coaxial cable.

45
25. The method for distributing radio frequency (RF) modulated broadcast
television signals from a broadcast signal source to networked appliances
connected to the source through a plurality of single conductor coaxial cables,
50
5 and simultaneously therewith distributing signals exchanged between the

5 networked appliances over the same coaxial cables, the exchanged signals
including RF modulated video signals from RF modulated video signal
appliances and unmodulated digital from digital signal appliances, the coaxial
10 cable having a cable characteristic impedance, the method comprising:

15 installing multi-drop signal distribution apparatus having a source input
for receiving the RF modulated broadcast television signals from the broadcast
source and having a plurality of output signal ports for receiving the RF
modulated video signals and unmodulated digital signals from each of the
plurality of coaxial cables;

20 coupling the RF broadcast signals within said signal distribution
apparatus, from said source input to each said output port;

coupling the RF modulated video signals and the unmodulated digital
signals received at each said output port to each other output port; without port-
25 to-port signal isolation; and

30 connecting each appliance to its associated coaxial cable through an
associated one of a plurality of signal frequency filters, including a digital signal
frequency filter having a frequency passband suitable to pass therethrough the
unmodulated digital signals at a selected signal bit speed, and including an RF
modulated video signal filter having a frequency passband suitable to pass
25 therethrough the RF modulated broadcast television signals and the RF
modulated video signals, each said filter being connected at a first terminal
thereof to the associated appliance and connected at a second terminal thereof to
the associated coaxial cable, each said providing a substantially equal filter
characteristic impedance to passband signals propagating bi-directionally
40 therethrough between the associated appliance and the coaxial cable.

26. The method of claim 25, wherein the passband of said RF modulated
45 video signal filter is at a higher frequency spectrum than the passband of said
digital signal filter.

5

27. The method of claim 25, wherein the step of connecting further includes the steps of:

10

5 identifying each digital signal appliance and each associated digital signal frequency filter; and

15

inserting a filter impedance matching network intermediate to the connection between each digital signal appliance and said first terminal of said associated digital signal frequency filter, said filter impedance matching network providing a terminating impedance value at said first terminal which approximates the cable characteristic impedance provided to said second terminal, thereby providing substantially equal filter characteristic impedance to unmodulated digital signals exchanged at a signal bit speed, bi-directionally, through said digital signal frequency filter.

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28. The method of claim 27, wherein said step of inserting further includes the step of:

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providing said impedance matching network as a series resistor functionally connected at a first side thereof to said first terminal of said digital signal filter and connected at a second side thereof to the digital signal appliance, said series resistor being further connected at said second side through a shunt resistor to the low voltage potential reference of the digital signal appliance.

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29. The method of claim 28, wherein said shunt resistor has a shunt impedance value which is substantially equal to the value of the cable characteristic impedance, and wherein said series resistor has a series impedance value which is in the range of from one third to two thirds of said shunt impedance value.

45

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30. The method of claim 25, wherein said digital signal frequency filter is at least a third order filter.

55

5 31. The method of claim 25, wherein said digital signal frequency filter is at least a fifth order filter.

10 32. The method of claim 26, wherein the frequency passband of said digital signal filter is substantially from zero hertz to 2.5 megahertz and the frequency passband of said RF video signal filter is greater than five megahertz.

15 33. The method of claim 27, wherein said signal bit speed of the unmodulated digital signal is a minimum of substantially 1.0 Mbps.

20 34. The method of claim 29, wherein said series impedance value is selected at a value within said range to minimize digital signal interference with the RF modulated video signals.

25 5 35. The method of claim 25, wherein said step of installing further includes the step of blocking the RF modulated video signals and unmodulated digital signals received at said output signal ports from being coupled to said source input.

10 36 The method of claim 25, wherein said step of installing includes inserting, at each said output port, an associated distribution apparatus impedance matching network connected in series between the associated said output port and said source input, for providing a terminating impedance value
35 at each said output port which approximates the cable characteristic impedance.
40 15

45 37. The method for distributing radio frequency (RF) modulated broadcast television signals from a broadcast signal source to networked appliances connected to the source through a plurality of single conductor coaxial cables,
50 20 while simultaneously distributing signals exchanged between the networked appliances over the same coaxial cables, the exchanged signals including RF modulated video signals from RF modulated video signal appliances and

5 unmodulated digital from digital signal appliances, the coaxial cable having a cable characteristic impedance, the method comprising:

10 installing multi-drop signal distribution apparatus having a source input for receiving the RF modulated broadcast television signals from the broadcast
5 source and having a plurality of output signal ports, each output signal port receiving the RF modulated video signals and unmodulated digital signals from an associated one of the plurality of coaxial cables;

15 coupling the RF broadcast signals within said signal distribution apparatus, from said source input to each said output port;

20 coupling the RF modulated video signals and the unmodulated digital signals received at each said output port to each other output port; without port-to-port signal isolation;

25 connecting each appliance to its associated coaxial cable through one of a plurality of signal frequency filters, each said filter being connected at a first
15 terminal thereof to the associated appliance and connected at a second terminal thereof to the associated coaxial cable, said plurality of signal filters including digital signal frequency filters having a frequency passband substantially from
30 zero hertz to 2.5 Megahertz, suitable to pass therethrough unmodulated digital signals between a digital signal appliance and the coaxial, said plurality of
20 signal filters further including RF modulated video signal filters having a frequency passband greater than five megahertz, suitable to pass therethrough the RF modulated broadcast television signals and the RF modulated video
35 signals between an RF modulated video signal appliance and the coaxial cable, each said providing a substantially equal filter characteristic impedance to
40 passband signals propagating bi-directionally therethrough between the
25 associated appliance and the coaxial cable; and

45 inserting an impedance matching network between the signal input and output (I/O) ports of each digital signal appliance and said first terminal of said associated digital signal frequency filter, said impedance matching network
30 providing a terminating impedance value at said first terminal which approximates the cable characteristic impedance provided to said second
50

5 terminal, thereby providing said bi-directional exchange of unmodulated digital
signals at a minimum signal bit speed of substantially with minimum digital
10 signal interference of the RF modulated video signals.

38. Apparatus for distributing radio frequency (RF) modulated broadcast
television signals from a broadcast signal source to networked appliances
15 connected to the source through a plurality of single conductor coaxial cables
and, concurrently and alternately therewith, distributing signals exchanged
5 between the networked appliances over the same coaxial cables, the exchanged
signals including RF modulated video signals from RF modulated video signal
20 appliances and unmodulated digital from digital signal appliances, the coaxial
cable having a cable characteristic impedance, the apparatus comprising:

10 multi-drop signal distribution apparatus, having a source input adapted
for receiving the RF modulated broadcast television signals from the broadcast
25 source and having a plurality of output signal ports, each adapted for receiving
the RF modulated video signals and unmodulated digital signals from an
associated one of the plurality of coaxial cables, said signal distribution
30 apparatus coupling the RF broadcast television signals from said source input to
15 each said output port and coupling the RF modulated video signals and the
unmodulated digital signals received at each said output port to each other
35 output port;

a plurality of digital signal frequency filters, each adapted for connection
20 at a first terminal thereof to the signal input and output (I/O) of a related one of
the digital signal appliances and adapted at a second terminal thereof for
40 connection to the networked appliance associated coaxial cable, each said
digital signal frequency filter having a frequency passband suitable to pass
unmodulated digital signals therethrough at a selected signal bit speed between
45 the digital signal appliance and the coaxial cable; and

25 a plurality of RF modulated video signal frequency filters, each adapted
for connection at a first terminal thereof to the signal (I/O) of a related one of
50 the RF modulated video signal appliances and adapted at a second terminal

5 thereof for connection to the networked appliance associated coaxial cable, each
30 said RF modulated video signal filter having a frequency passband suitable to
pass the RF modulated broadcast television signals and the RF modulated video
10 signals bi-directionally therethrough between the associated appliance and the
coaxial cable.

15 39. The apparatus of claim 38, wherein the passband of said RF modulated
video signal filters is at a higher frequency spectrum than the passband of said
digital signal filters.

20 40. The apparatus of claim 38, further comprising:

a plurality of impedance matching networks, one each inserted between
the digital signal apparatus signal I/O ports and said first terminal of said digital
25 5 signal frequency filter, said impedance matching network providing a
terminating impedance value at said first terminal which approximates the cable
characteristic impedance provided by the coaxial cable to said second terminal,
thereby providing said substantially equal filter characteristic impedance to
30 unmodulated digital signals exchanged bi-directionally, at a signal bit speed,
10 through said digital signal frequency filter.

35 41. The apparatus of claim 40, wherein each said impedance matching
network comprises:

a series resistor functionally connected at first and second sides thereof
40 5 to said first terminal and to the digital signal apparatus signal I/O ports,
respectively, said series resistor being further connected at said second side
through a shunt resistor to the low voltage potential reference of the digital
signal apparatus signal I/O ports.

45 42. The apparatus of claim 41, wherein said shunt resistor has a shunt
impedance value which is substantially equal to the value of the cable
50 characteristic impedance, and wherein said series resistor has a series impedance

5 value which is in the range of from one third to two thirds of said shunt impedance value.

10 43. The apparatus of claim 38, wherein said digital signal frequency filter is at least a third order filter.

15 44. The apparatus of claim 38, wherein said RF video signal frequency filter is at least a third order filter.

20 45. The apparatus of claim 38, wherein said digital signal frequency filter is at least a fifth order filter.

25 46. The apparatus of claim 39, wherein the frequency passband of said digital signal filter is substantially from zero hertz to 2.5 megahertz and the frequency passband of said RF video signal filter is greater than five megahertz.

30 47. The apparatus of claim 40, wherein said signal bit speed of the unmodulated digital signal is a minimum of substantially 1.0 Mbps.

35 48. The apparatus of claim 41, wherein said series impedance value is selected at a value within said range to minimize digital signal interference with the RF modulated video signals.

40 49. Apparatus, for distributing radio frequency (RF) modulated broadcast television signals from a broadcast signal source to networked appliances distributed in selected locations and connected to the source through associated
5 ones of a plurality of single conductor coaxial cables, and for also distributing, concurrently and alternately therewith in response to infrared (IR) command
45 signals received from IR signal sources controlled by an operator, signals exchanged between the networked appliances over the same coaxial cables, the exchanged signals including RF modulated video signals from RF modulated
50 10 video signal appliances, unmodulated digital from digital signal appliances, and

5 the received IR command signals, the different type appliances and the source of
IR command signals each having different operating signal frequency ranges,
10 the coaxial cable having a cable characteristic impedance, the apparatus
comprising:

15 a plurality of IR transceivers, at least one located in line-of-sight
proximity to the networked appliances in each selected area, each said IR
15 transceiver responsive to IR command signals received through the air from IR
signal sources in the area for providing an equivalent electrical command signal
thereof, and each transmitting IR command signals through the air to appliances
20 in the area in response to equivalent electrical command signals received
thereby;

a plurality interface apparatus, one each associated with one or more
25 appliances and IR transceivers within a selected area, said interface apparatus
having a digital signal frequency filter, an electrical command signal frequency
25 filter, and an RF modulated video signal frequency filter, each having a different
bandpass frequency which encompass the different operating signal frequency
30 ranges of the unmodulated digital signals, the electrical command signals, and
the RF modulated television signals and video signals, respectively; said digital
signal frequency filter being interconnected at first and second terminals thereof
30 between the signal input and output (I/O) ports of a digital signal appliance and
the coaxial cable, said electrical command signal frequency filter being
35 interconnected at first and second terminals thereof between an IR transceiver
and the coaxial cable, and said RF modulated video signal frequency filter being
interconnected at first and second terminals thereof between the signal I/O ports
40 of an RF modulated video signal appliance and the coaxial cable, wherein each
said frequency filter bi-directionally couples operating signals within their
35 respective bandpass frequencies between the associated appliance and the
coaxial cable; and

45 a signal distribution unit, having a source input for receiving the RF
40 modulated broadcast television signals, and having a plurality of output signal
ports for receiving the unmodulated digital signals, the electrical command
50

5 signals, and the RF modulated video signals provided through an associated one
of the coaxial cables from each of said interface apparatus, said signal
distribution unit coupling the RF broadcast television signals from said source
10 input to each said output port and coupling the unmodulated digital signals, the
electrical command signals, and the RF modulated video signals received at
each said output port to each other said output port.

15
50. The apparatus of claim 49, wherein said interface apparatus further
50 includes an interface impedance matching network interconnected between the
digital signal appliance signal I/O ports and said first terminal of said digital
signal frequency filter, said interface impedance matching network
20 providing a terminating impedance value at said first terminal which
approximates the cable characteristic impedance provided by the coaxial cable
to said second terminal, thereby providing said substantially equal filter
25 characteristic impedance to unmodulated digital signals exchanged bi-
directionally, at a signal bit speed, through said digital signal frequency filter.

30
51. The apparatus of claim 50, wherein each said interface impedance
matching network comprises:

35 a series resistor functionally connected at first and second sides thereof
5 to said first terminal and to the digital signal appliance signal I/O ports,
respectively, said series resistor being further connected at said second side
through a shunt resistor to the low voltage potential reference of the digital
40 signal appliance signal I/O ports.

45
52. The apparatus of claim 51, wherein said shunt resistor has a shunt
impedance value which is substantially equal to the value of the cable
characteristic impedance, and wherein said series resistor has a series impedance
5 value which is in the range of from one third to two thirds of said shunt
impedance value.

53 The apparatus of claim 52, wherein said series impedance value is selected at a value within said range to minimize digital signal interference with the RF modulated video signals.

54. The apparatus of claim 50, wherein said signal distribution unit further includes:

a signal distribution bus connected for response to said source input and to each of said plurality of output ports, for distributing said RF modulated broadcast television signals to each said output port, and for distributing the unmodulated digital signals, the electrical commands signals, and the RF modulated video signals received at each output port from the port connected coaxial cable, to each other output port; and

a plurality of distribution unit impedance matching networks, one each connected between an associated one of said plurality of output ports and said distribution unit signal bus, for providing a terminating impedance value at each said output port which approximates the cable characteristic impedance.

55. The apparatus of claim 54, wherein said signal distribution bus has a maximum physical length which is selected to prevent standing wave signal interference of the apparatus distributed signals.

56. The apparatus of claim 55, wherein said signal distribution bus maximum physical length is less than a quarter wavelength of the highest frequency distributed signal.

57. The apparatus of claim 49, wherein the frequency passband of said digital signal filter is substantially from zero hertz to 2.5 megahertz, the frequency passband of said electrical command signal filter is substantially from 2.4 megahertz to 5.0 megahertz, and the frequency passband of said RF video signal filter is greater than five megahertz.

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58. The apparatus of claim 49, wherein said digital signal frequency filter is at least a third order filter.

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59. The apparatus of claim 49, wherein said RF video signal frequency filter is at least a third order filter.

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60. The apparatus of claim 49, wherein said electrical command signal frequency filter is at least a third order filter.

10 61. A multi-drop signal distribution apparatus, comprising:
a source input for receiving RF modulated signals from a broadcast
20 source; and
a plurality of signal ports, each port adapted for receiving a plurality of modulated signals, including at least said RF modulated signals, and for
25 15 receiving digital signals from associated ones of a plurality of coaxial cables connectable to each of said signal ports.

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62. An apparatus as in claim 61, further comprising:
first circuit elements coupling RF broadcast modulated signals to be
20 received at said source input to each one of said plurality of signal ports; and
second circuit elements coupling RF modulated signals at each signal
35 port and any digital signals to be received at each signal port to each other signal port of said plurality of signal ports.

40

25 63. An apparatus as in claim 61 further comprising:
an amplifier connected to said source input for alternating signals
received at said source input, and adapted for attenuating lower frequency
signals received at said source input by a greater amount than the attenuating of
45 higher frequency signals received at said source input; and
30 a plurality of high pass filters connected for receiving said signals from
said amplifier, corresponding respectively to said plurality of signal ports, and

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5 adapted for providing low impedance coupling of said RF modulated signals to
each one of said plurality of signal ports.

10 64. An apparatus as in claim 62 further comprising:

5 an amplifier connected to said source input for alternating signals
received at said source input, and adapted for attenuating lower frequency
signals received at said source input by a greater amount than the attenuating
15 higher frequency signals received at said source input; and

a plurality of high pass filters connected for receiving said signals from
10 said amplifier, corresponding respectively to said plurality of signal ports, and
adapted for providing low impedance coupling of said RF modulated signals to
each one of said plurality of signal ports.

25 65. An apparatus as in claim 64 further comprising:

15 a plurality of low pass filters corresponding respectively to said plurality
of signal ports, each one connected to a corresponding signal port, and to said
means for coupling each signal port to each other signal port, and each one of
said low pass filters adapted for preventing said RF modulated signals from
30 being passed to said means for coupling each signal port to each other.

20 66. An apparatus as in claim 65 wherein said means for coupling each signal
port to each other comprises a low frequency bus for carrying low frequency
35 data and information band signals, and command and control band signals, and
for coupling said data and information band signals, and command and control
band signals, to individual ones of said plurality of signal ports for being
40 transmitted onto a network connectable to the apparatus.

45 67. An interface apparatus connectable to networked appliances distributed
in selected locations and connected to a source of RF modulated signals through
30 associated ones of a plurality of single conductor coaxial cable, comprising:

an RF modulator for transmitting said RF modulated signals and for
50 generating an RF television channel on one of plural reserved spectrum channels

5 from baseband audio and video signals receivable from an appliance to be associated therewith;

10 a processing circuit connected to said RF modulator for programming the modulator by sending bytes for initializing a picture carrier frequency, a sound subcarrier frequency and a video modulation depth; and

15 an impedance matching network connected between I/O ports connectable to an appliance and said processing circuit, for providing an impedance value to signals at a connection to an appliance which approximates the characteristic impedance provided by coaxial cable.

20 68. An apparatus as in claim 67 wherein said interface impedance matching network comprises:

25 a series resistor functionally connectable at first and second sides thereof to an appliance, and further connected at said second side through a shunt resistor to ground.

30 69. An interface apparatus as in claim 67 further comprising a digital signal frequency filter, an electrical command signal filter, and an RF modulated video signal frequency filter, each having a different bandpass frequency which
20 encompass different operating signal frequency ranges of unmodulated digital signals, electrical command signals, and RF modulated signals and video signals
35 respectively, said digital signal frequency filter interconnectable at first and second terminals thereof between I/O ports of an appliance and the coaxial cable, said electrical command frequency filter being interconnectable at first
40 and second terminals thereof between an IR transceiver and the coaxial cable, and said RF modulated video signal frequency filter being interconnectable at first and second terminals thereof between signal I/O ports of an appliance and the coaxial cable, whereby each one of said filters serve to bidirectionally
45 couple operating signals within their respective bandpass frequencies between
30 an associated appliance and the coaxial cable.

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70. An apparatus as in claim 68 wherein said series resistor is functionally connectable at the first and second sides thereof to said first terminal and through the RF modulator to the appliance I/O ports respectively, and said series resistor being further connectable at said second side through said shunt resistor to the low voltage potential reference of the appliance I/O ports which is ground.

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FIG. 1A

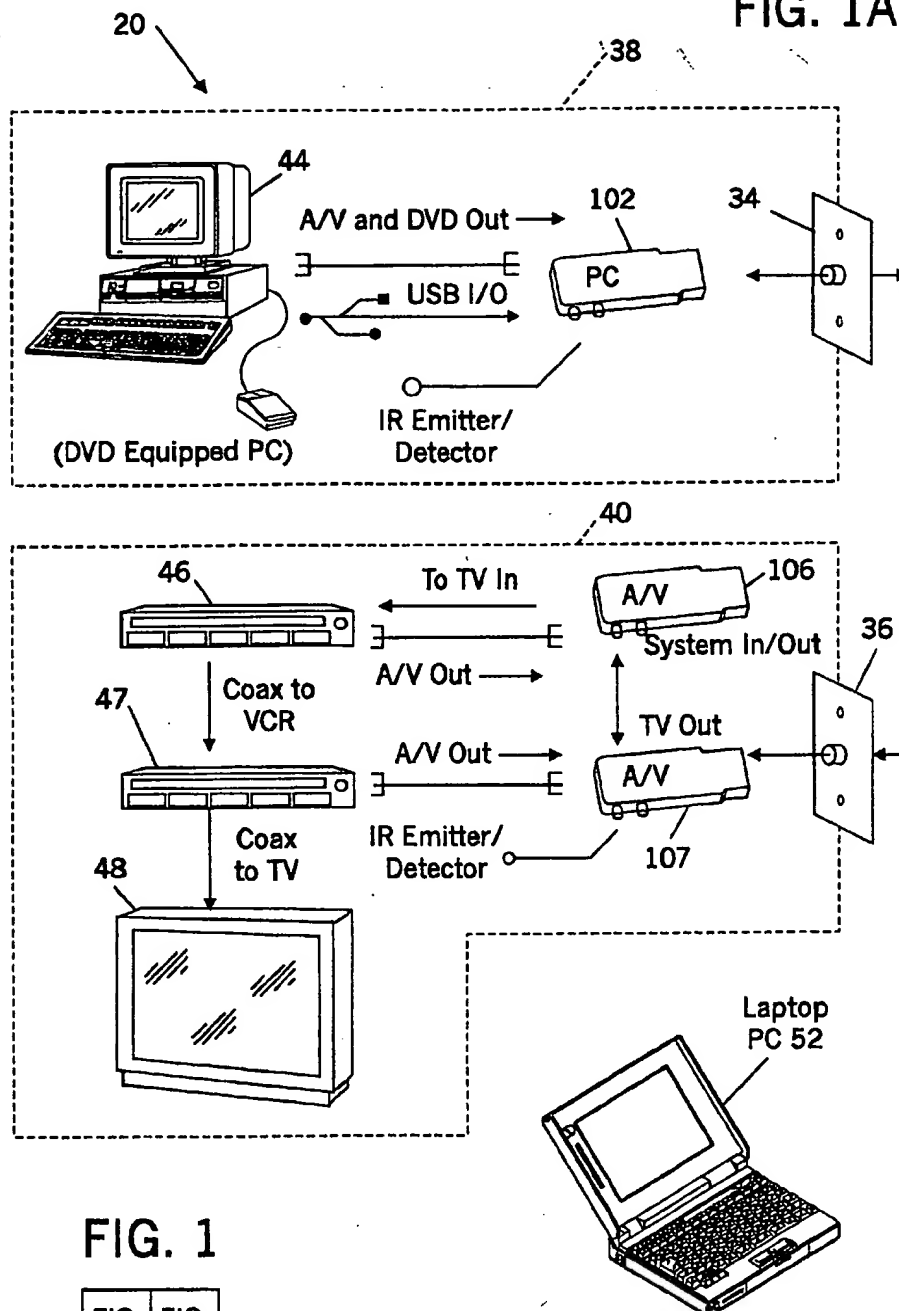
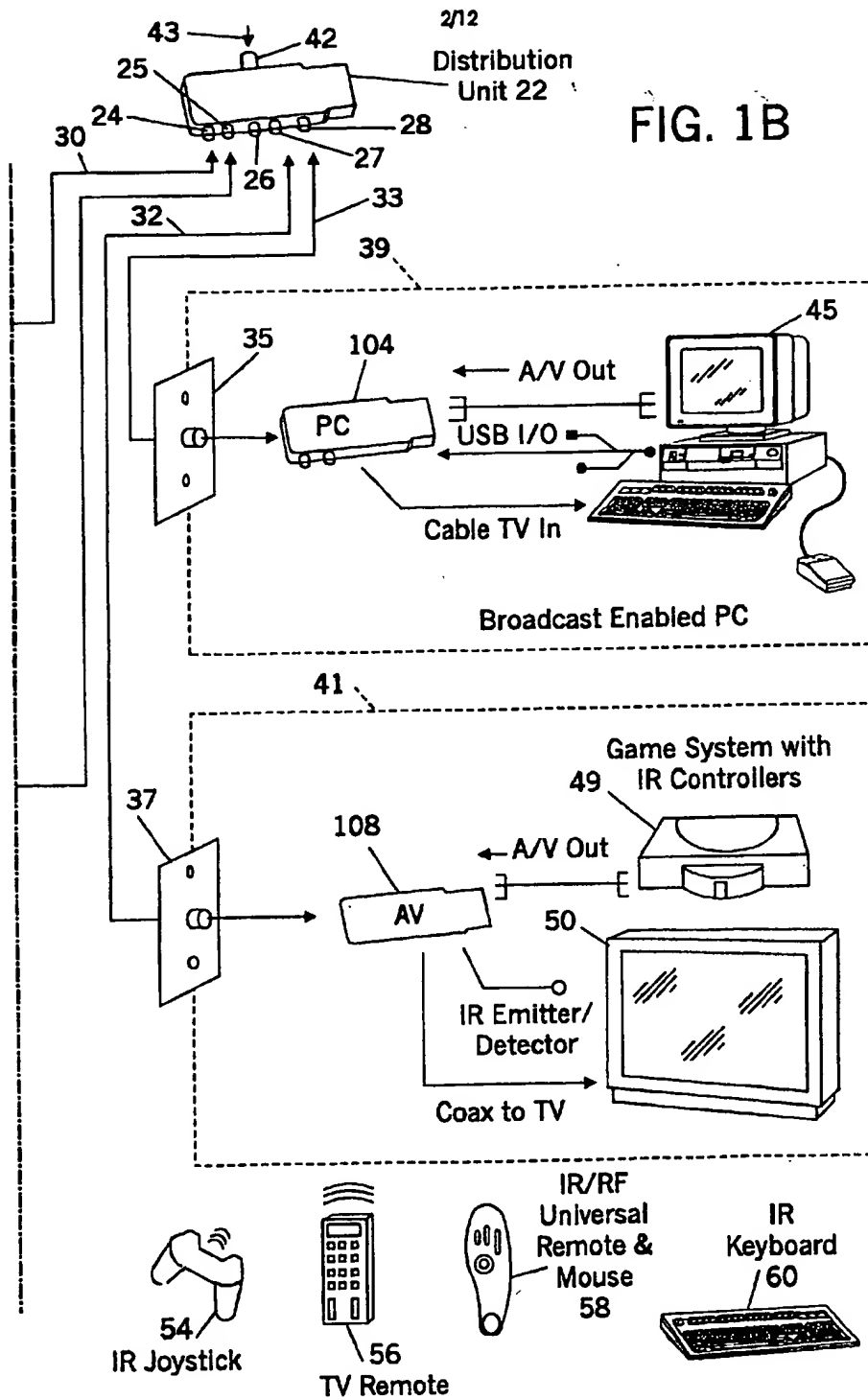


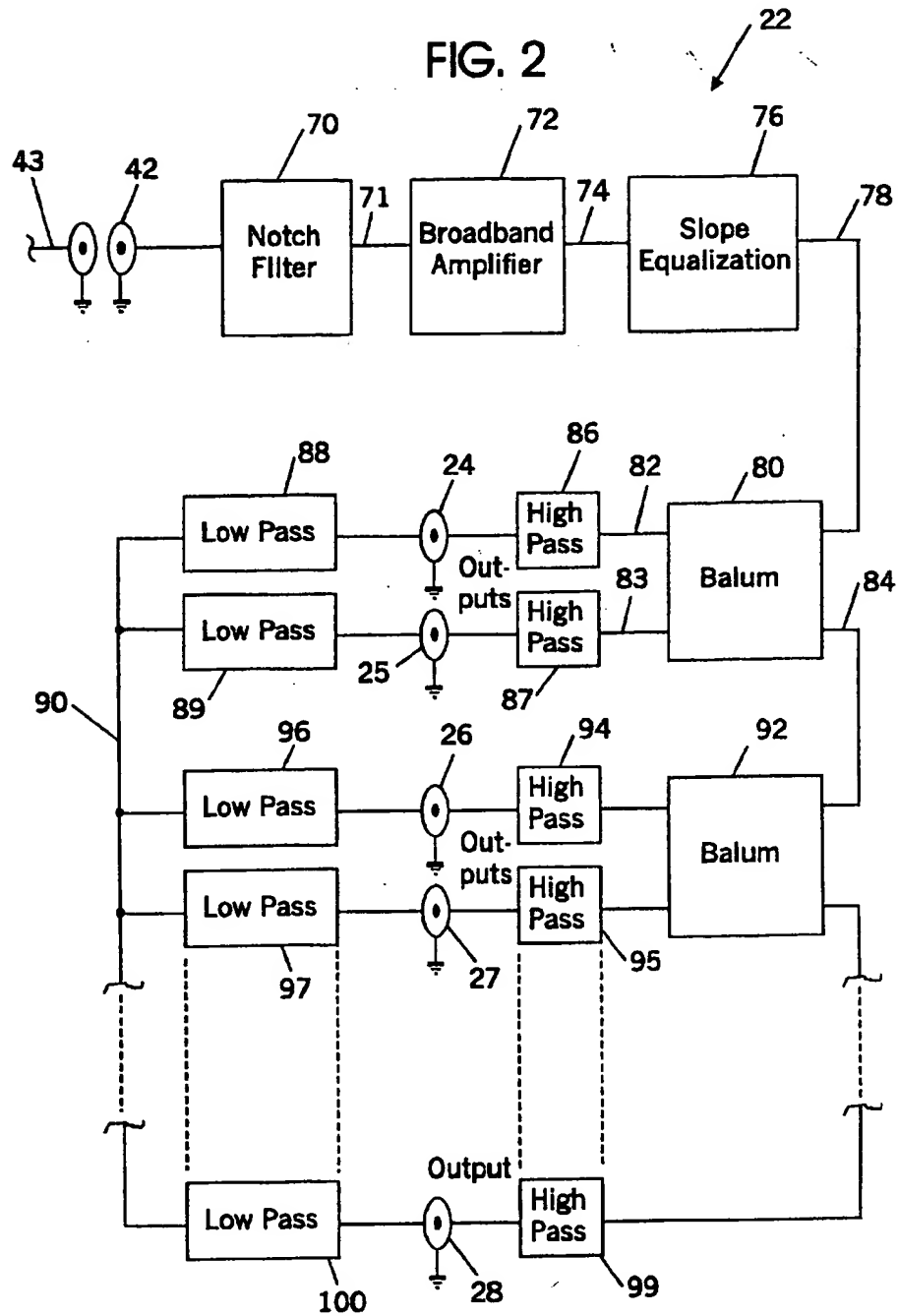
FIG. 1

FIG. 1A	FIG. 1B
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FIG. 2



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FIG. 3

5 MHz High Pass Filter

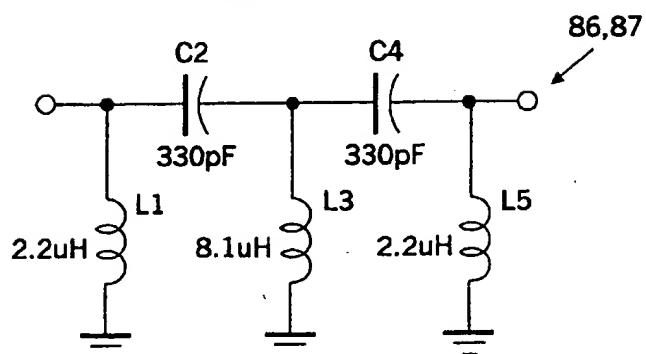
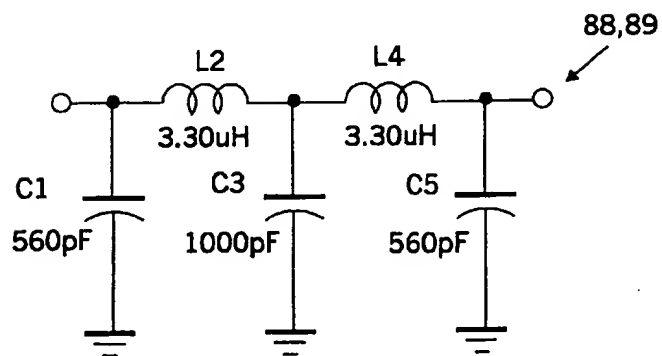


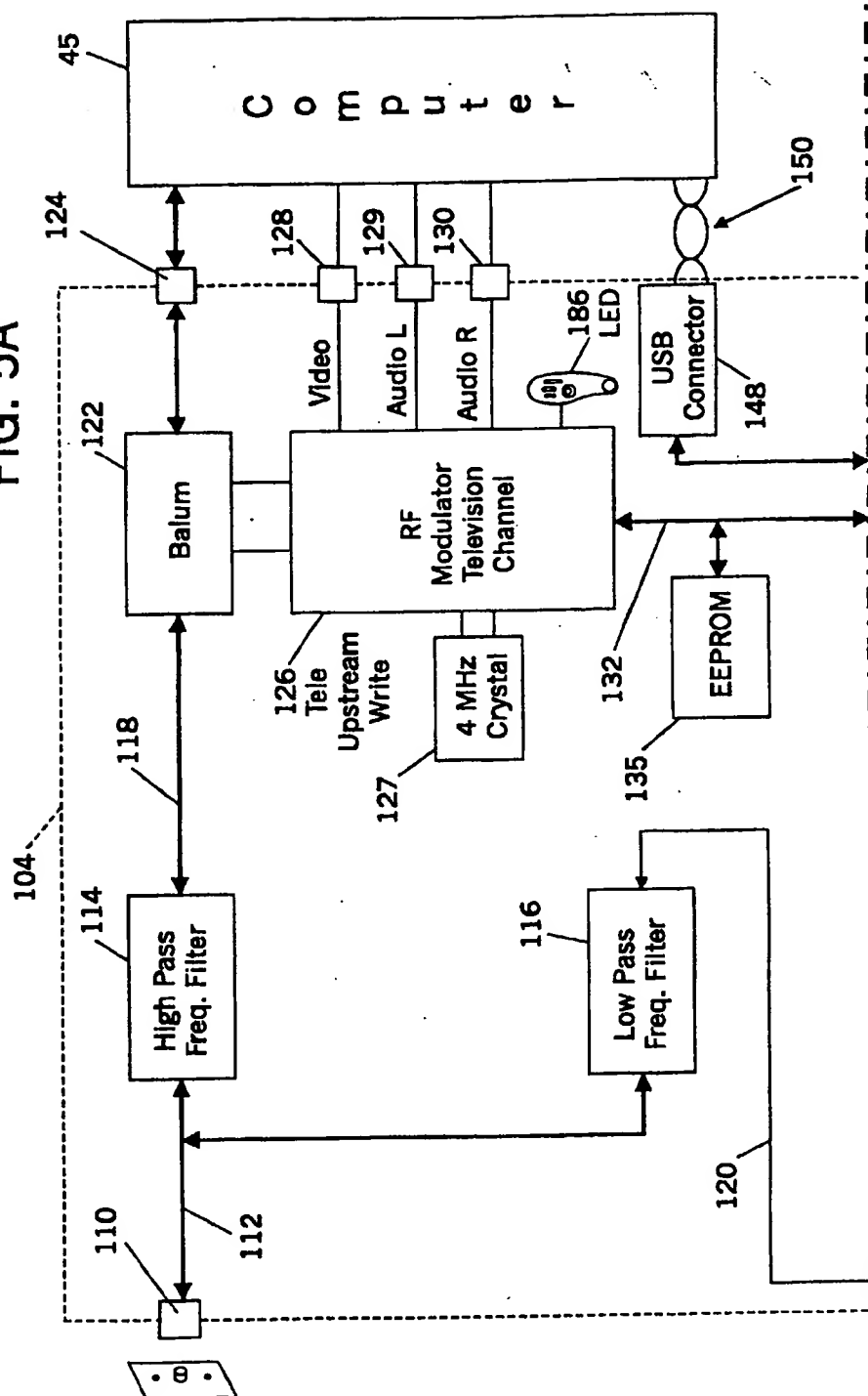
FIG. 4

4.5 MHz Low Pass Filter

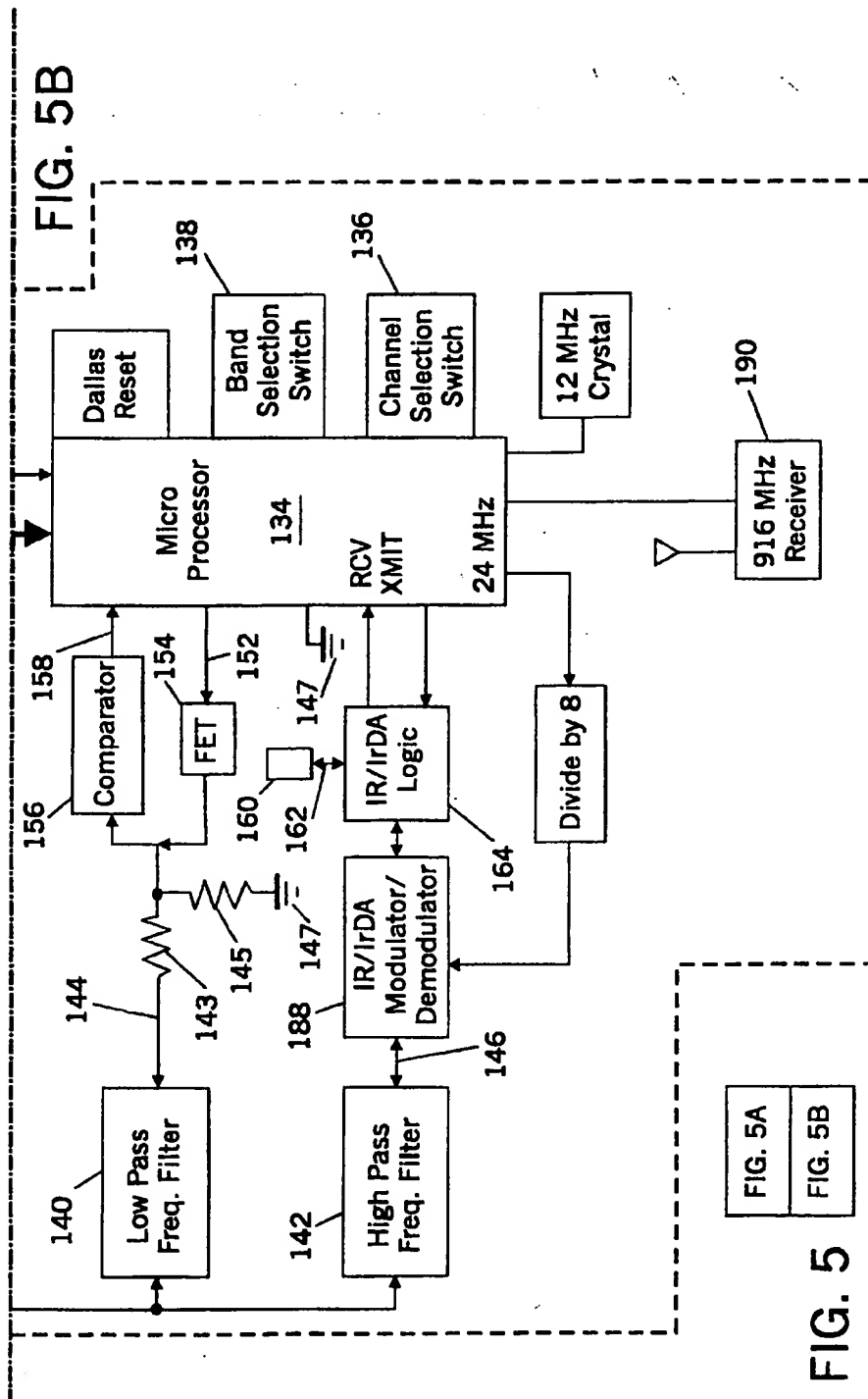


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FIG. 5A



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FIG. 6
2.5 MHz High Pass Filter

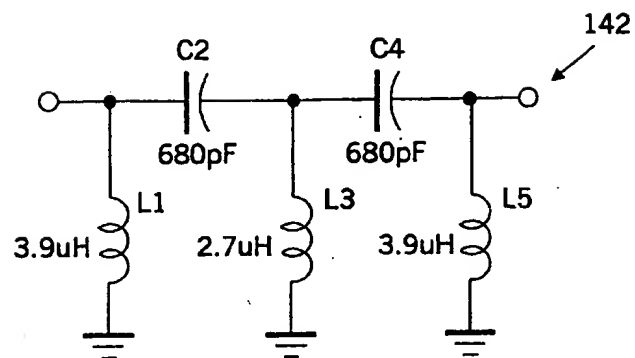
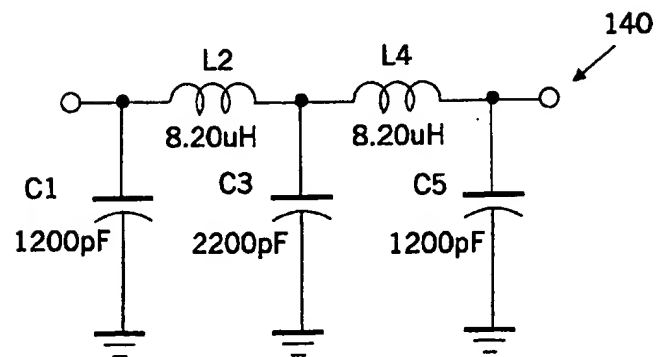


FIG. 7
2.5 MHz Low Pass Filter



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FIG. 8

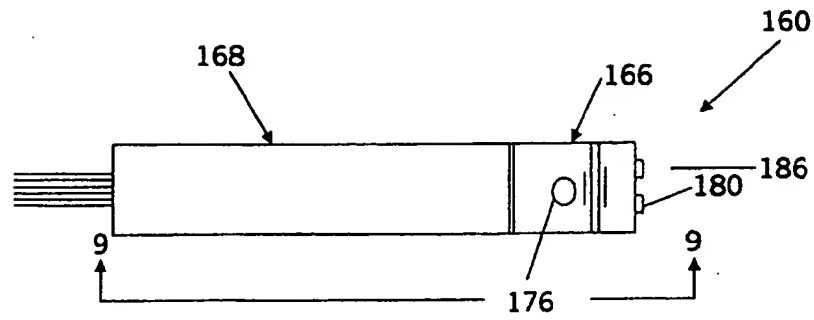


FIG. 9

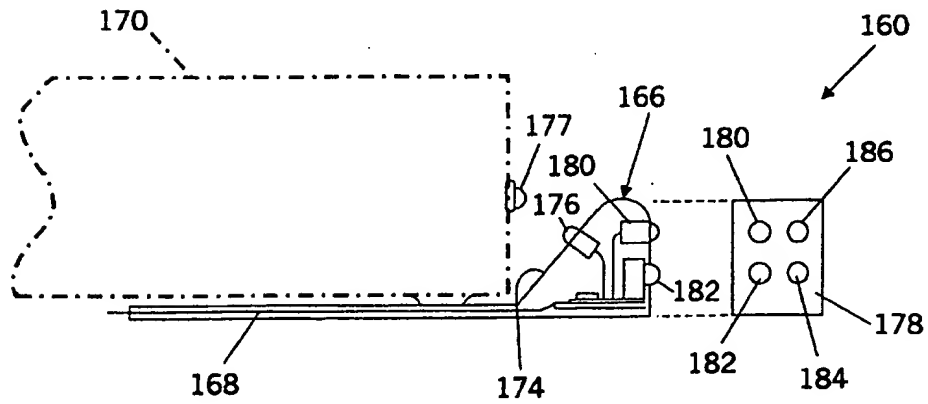
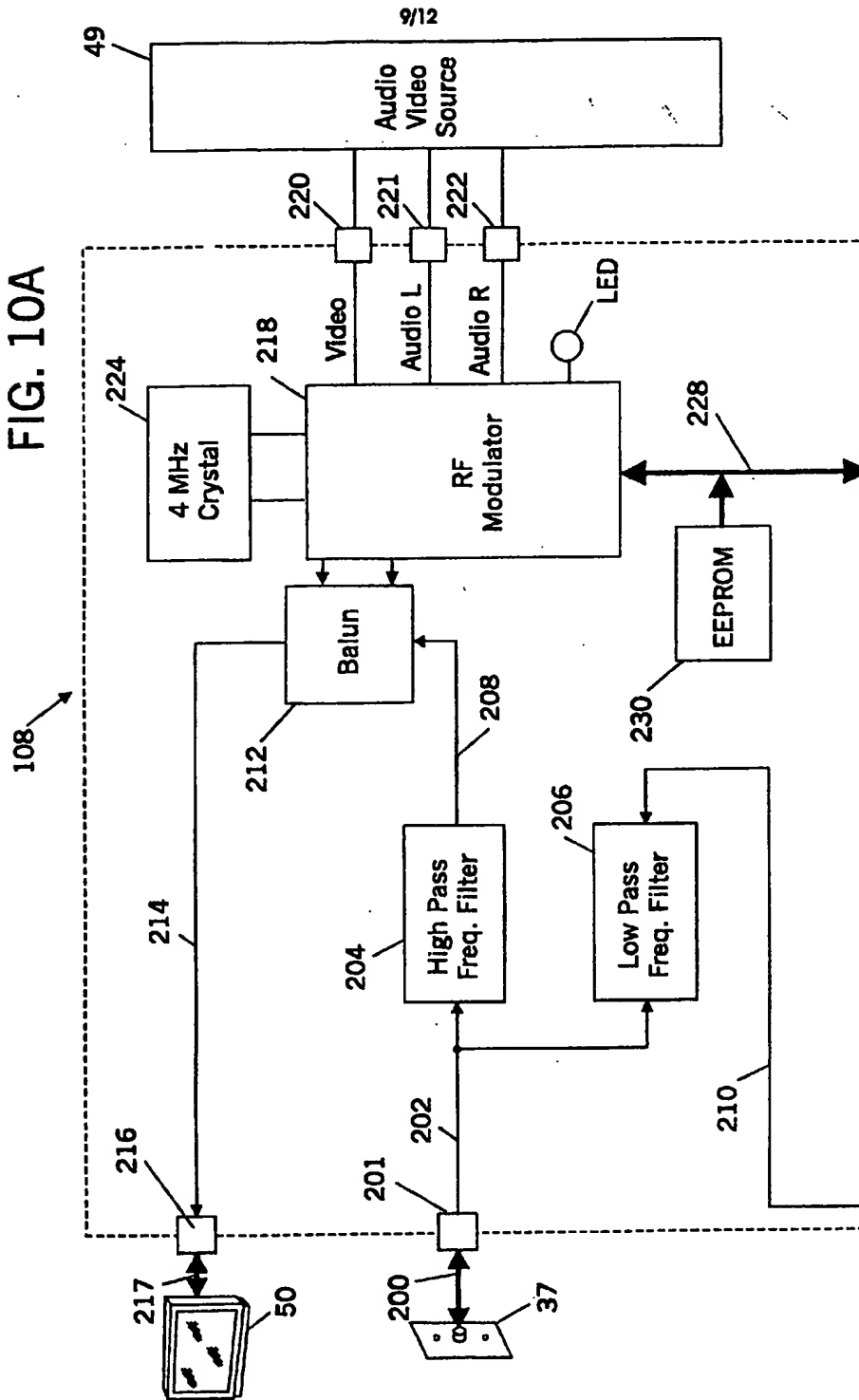


FIG. 10A



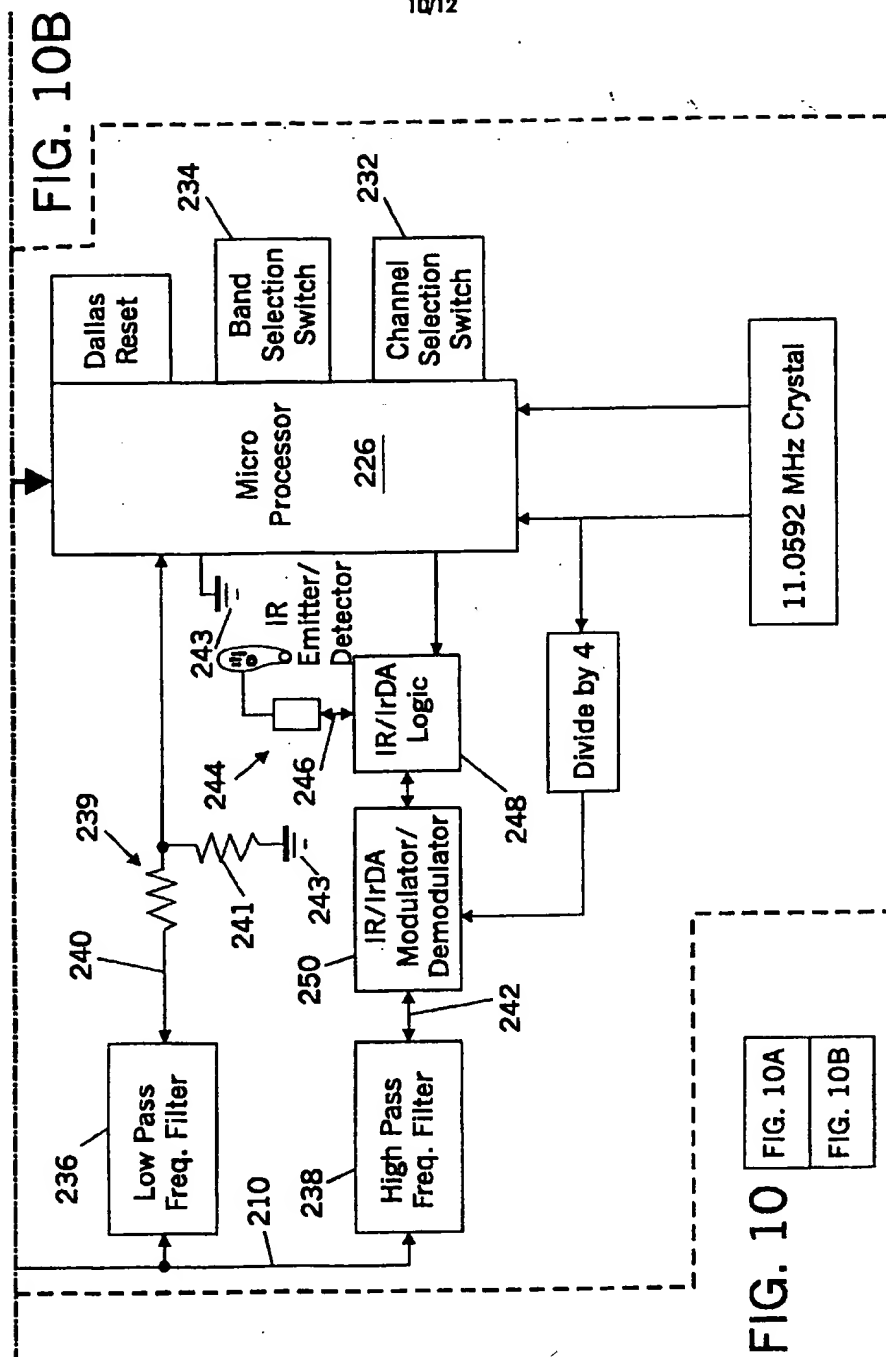
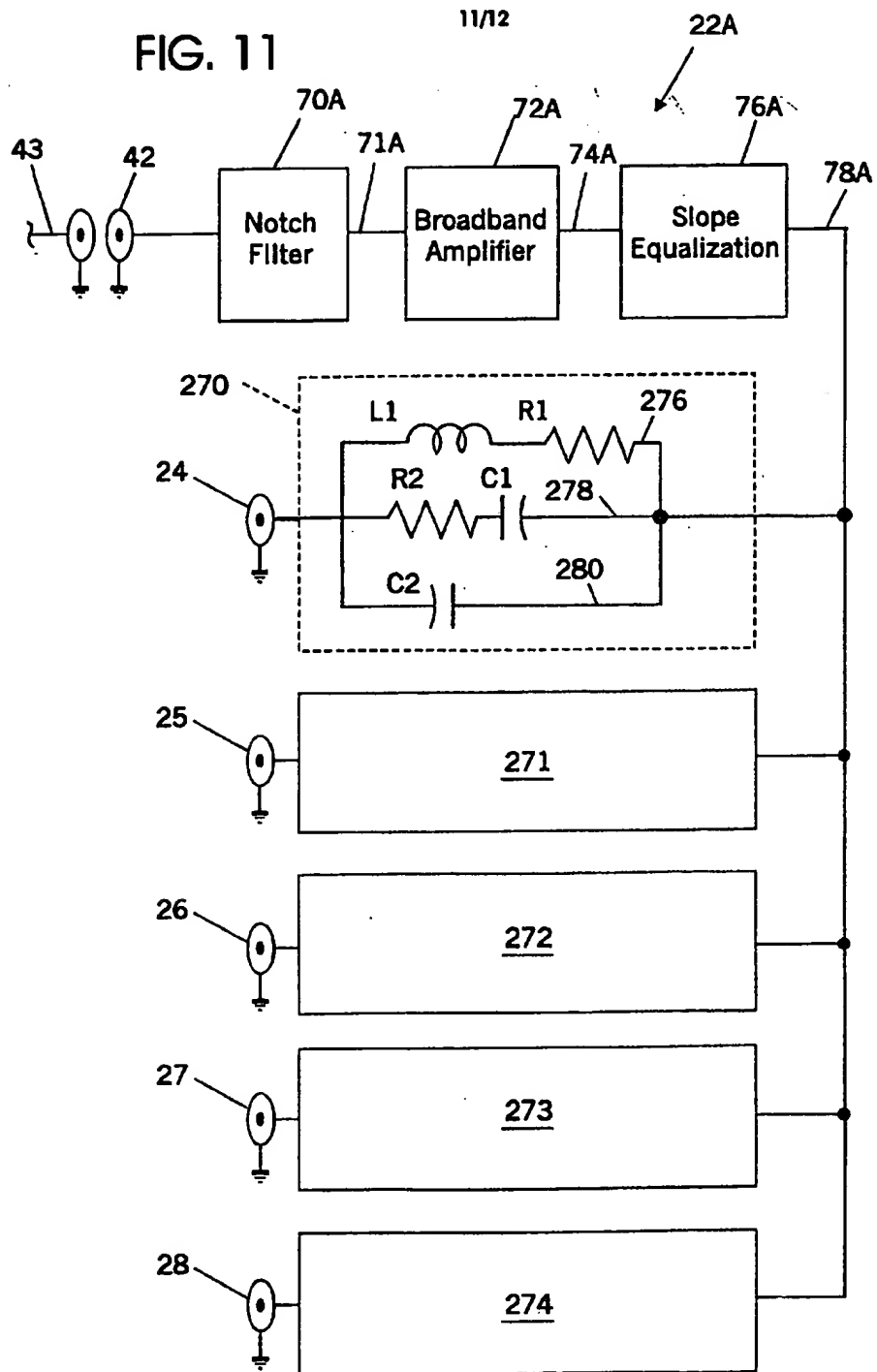


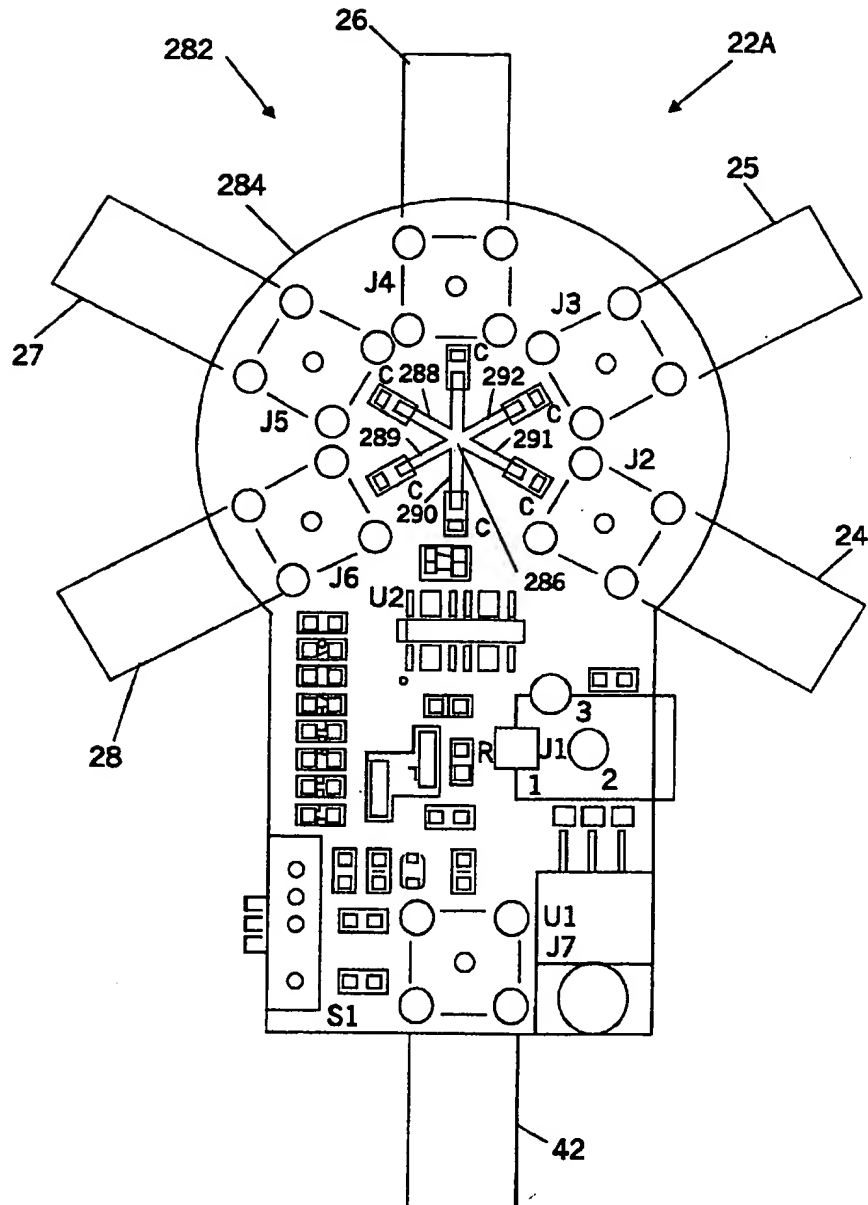
FIG. 11



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FIG. 12



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